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## Monterey, California



# THESIS

RESERVE MANNING OF FF-1052 AND FFG-7 CLASS FRIGATES:  
A CRITIQUE OF THE ACCURACY AND COMPLETENESS  
OF EXISTING COSTING STUDIES

by

Patrick Robert Rearden

March 1987

Thesis Advisor:

Kenneth J. Coffey

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The thesis observed that the actual costs of operating an FF-1052 class ship in the NRF was higher than in the Regular Navy; FFG-7 units proved to be less costly in the NRF.



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Reserve Manning of FF-1052 and FFG-7 Class Frigates:  
A Critique of the Accuracy and Completeness  
of Existing Costing Studies

by

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Submitted in partial fulfillment of the  
requirements for the degree of

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from the

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## ABSTRACT

The purposes for this research have included:

1. To evaluate studies that have attempted to make a cost analysis of either Regular Navy or Naval Reserve Force ships.
2. To collect and analyze data related to the costs of operating selected Regular Navy and NRF ships during Fiscal Year 1986.

The focus of this work were the costs observed by eight selected Pacific Fleet frigates. Of the eight, four each belonged to the Regular Navy and the NRF. Of these, two ships were of the FF-1052 (Knox) class, while the other two belonged to the FFG-7 (Perry) class.

Operating costs were divided into three families: manpower, equipment and supplies, and variable costs of operation. Data was obtained in most cases from original documents and ship's manning records.

The thesis observed that the actual costs of operating an FF-1052 class in the NRF was higher than to do so in the Regular Navy. By contrast, FFG-7s proved to be more economical when associated with the Naval Reserve Force.

## TABLE OF CONTENTS

|      |   |     |
|------|---|-----|
| I.   | INTRODUCTION . . . . .  | 7   |
|      | A. THESIS OVERVIEW . . . . .  | 7   |
|      | B. ORGANIZATION OF THE THESIS . . . . .                               | 10  |
|      | C. THE SCOPE OF UNIT COST ANALYSIS . . . . .                          | 12  |
|      | D. SCOPE OF CURRENT COSTING STUDIES . . . . .                         | 18  |
|      | E. FRIGATE MANNING AND OPERATIONS . . . . .                           | 21  |
|      | F. INTRODUCTORY COMMENTS . . . . .                                    | 26  |
| II.  | UNIT MANPOWER COSTS . . . . .   | 28  |
|      | A. BASIC PAY AND ALLOWANCES . . . . .                                 | 33  |
|      | B. SEA PAY . . . . .  | 43  |
|      | C. UNIQUE NAVAL RESERVE FORCE COSTS . . . . .                         | 47  |
|      | D. TRAVEL COSTS . . . . .   | 53  |
|      | E. RECRUITING AND INITIAL TRAINING COSTS . . . . .                    | 61  |
|      | F. SELECTIVE REEENLISTMENT BONUSES AND<br>ADVANCED TRAINING . . . . . | 75  |
|      | G. RETIREMENT COSTS . . . . .   | 81  |
| III. | UNIT EQUIPMENT AND MAINTENANCE COSTS . . . . .                        | 90  |
|      | A. ORGANIZATION AND MAINTENANCE SUPPLIES . . . . .                    | 92  |
|      | B. REPAIR PARTS . . . . .   | 101 |
|      | C. INTERMEDIATE- AND HIGHER-LEVEL MAINTENANCE . . . . .               | 108 |
|      | D. BASE OPERATING COSTS . . . . .                                     | 129 |
| IV.  | UNIT OPERATING COSTS . . . . .  | 144 |
|      | A. PETROLEUM, OIL, AND LUBRICANTS . . . . .                           | 144 |

|             |  |     |
|-------------|--|-----|
|             | B. TRAINING AMMUNITION AND EXPENDABLE<br>STORES . . . . .        | 153 |
|             | C. UTILITY COSTS . . . . .                                       | 158 |
|             | D. UNIT PROVISIONS COSTS . . . . .                               | 164 |
|             | E. OPERATING VARIABLE COSTS CORRECTION . . . . .                 | 169 |
| V.          | UNIT COST SUMMARY . . . . .                                      | 178 |
| VI.         | CONCLUSIONS . . . . .  | 180 |
|             | A. UNIT COST ANALYSIS . . . . .                                  | 180 |
|             | B. COSTING STUDIES CRITIQUE . . . . .                            | 184 |
|             | C. OBSERVATIONS . . . . .  | 187 |
| APPENDIX A: | HISTORY AND ORGANIZATION OF THE NAVAL<br>RESERVE FORCE . . . . . | 190 |
| APPENDIX B: | SHIP CLASS CHARACTERISTICS . . . . .                             | 196 |
|             | LIST OF REFERENCES . . . . .                                     | 200 |
|             | INITIAL DISTRIBUTION LIST . . . . .                              | 205 |

## I. INTRODUCTION

### A. THESIS OVERVIEW

An ongoing debate centers around the issues of cost and readiness in the military. The United States has traditionally been a nation that has favored mobilization of the citizen-soldier over maintaining a large standing armed service. The position of the nation today, as the bedrock of the Western alliance, has appeared to demand a substantial force of active duty soldiers and sailors. These personnel are deployed overseas or are ready for immediate employment at no small expense to the American taxpayer. The alternative, to train and equip civilians temporarily for military service when emergencies arise, has its own price in training and readiness that must be considered.

The fundamental question then, is whether the United States need expend limited resources in maintaining its armed forces in their present state and if not, then identify the structure of the optimal force.

This thesis takes the larger question of total military resources and focuses the subject to within the boundaries of naval surface combatant manning. Need we have a standing naval force manned exclusively by active duty (AD) personnel? Is a force structure that emphasizes the resources of



our citizen sailors more affordable?<sup>1</sup> What are the opposing costs and resulting impact of each upon our national defense goals?

To provide further insights into this issue, this thesis will:

1. Introduce and evaluate the costing models developed by previous studies.
2. Isolate reliable data sources or effective costing equations.
3. Evaluate actual costs observed in operating comparable Reserve and active duty frigates of the FF-1052 (Knox) and FFG-7 (Oliver Hazard Perry) classes. (What are the everyday costs of fuel, supplies, and replacement spares that the ship needs to operate?)
4. Evaluate the indirect cost effects of the transfer of these ships from the active duty force to the Naval Reserve Force (NRF). (In a world of constrained assets, do active duty frigates spend more time at sea, as more of their sister-ships leave active service to join the NRF?)
5. Formulate an improved costing system that integrates the experience of past researchers.

One of the premiere benefits that this study enjoys is

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<sup>1</sup>The organization of the Naval Reserve and its application to this thesis is described in greater detail in Appendix A.

that these ships, which have been the topic of recent research efforts, have now been in both active duty and reserve service long enough to approach the steady-state condition for manpower and operational costing. While lead ships of both classes entered active service in the 1970's, it was only in Fiscal Year (FY) 1982 that the Navy transferred the first four ships of the FF-1052 class to the NRF. Studies conducted previously have targetted the problem in theory or, in those cases where observations were recorded, in conditions that may have been unstable.

What this study will endeavor to do then, is to document the costs of these ships as they now operate. The methodology that this employs is to evaluate the existing secondary references and data sources (many of which were the subjects of previous studies) and to focus the costing problem on individual ships and associated supporting shore commands. A sample of both active duty and reserve frigates will be considered in this manner. Primary sources and data will be developed from interviews conducted with the current principle operators, planners, and theorists in the NRF Anti-Submarine Warfare (ASW) Frigate Implementation Program. The nature of the data will be examined in much greater detail as the thesis discusses each costing sub-category.

## B. ORGANIZATION OF THE THESIS

This thesis consists of an abstract, six chapters, and two appendices.

### 1. Abstract

A brief executive summary, highlighting the methodology of the thesis, the nature and success of data collection efforts, noteworthy exceptions in costing philosophy, an analysis of the data, and abbreviated conclusions.

### 2. Chapter I - Introduction

Introduces the purposes and scope of the thesis.

### 3. Chapter II - Unit Manpower Costs

This chapter deals with the issues associated with manpower assignments to active duty and Naval Reserve Force frigates. It summarizes the nature of the costs found in each of the sub-categories that comprise the total manpower equation, and isolates the techniques (and relative merit) of other contemporary costing analyses.

### 4. Chapter III - Unit Equipment and Maintenance Costs

This chapter isolates and evaluates the fixed and variable costs of ship maintenance, equipment operation, and supply consumption. The costing technique that is applied here is compared with those of other analyses.

## 5. Chapter IV - Unit Operating Costs

The thesis isolates those costing sub-categories whose values may vary with operating time at sea, for the purpose of eliminating standard cost biases. The topic is summarized, the individual sub-categories analyzed and, after the variable cost correction has been defined, the correction is then applied to the earlier findings to develop a standardized operating cost for all ship categories.

## 6. Chapter V - Unit Cost Summary

This chapter collects each of the individual costs identified for the ships in this survey and, after averaging them by class and organization, presents them in a comparative table format. General provisions and observations relevant to the summary costs are included here.

## 7. Chapter VI - Conclusions

Summarizes the results of this analysis, in terms of the following:

- a. The immediate significance of costs identified by the survey.
- b. Overall evaluation of the costing analyses that were studied in detail earlier.
- c. Summary of new or controversial techniques used by this thesis.
- d. Recommendations and projections.

## 8. Appendices

The two appendices provide background information and supplementary data that contribute to the development of this thesis or the reader's basic understanding of the problem:

### a. History and Organization of the Naval Reserve Force

This brief attachment outlines the recent history and organization of the Naval Reserve Force. It presents Naval Reserve manning policies and operating characteristics with particular emphasis placed upon the Naval Reserve ASW Frigate Program.

### b. Characteristics of the FFG-7 and FF-1052 Class Frigates

Provides unclassified information concerning the ship classes of which the units in this survey are a part. More specific information concerning each of the survey units is also included here, that is not referred to in the text.

## C. THE SCOPE OF UNIT COST ANALYSIS

The first major step that unit cost analysis involves is to classify each cost according to its organizational association. Simply, is the cost one that applies solely to the NRF unit, the active duty unit, or is it a common cost? In many instances, the nature of these costs is clear: costs involved with crew training for Selected Reservists on the



NRF unit are clearly costs chargeable to the NRF account. In the same manner, basic training for enlistees whose ultimate duty station is an AD ship might reasonably be debited to the active account. But wait . . . if because the enlistee serves his enlistment and then joins one of the NRF units (as a reservist) does the cost of all previous training then pass to the reserve account?

This thesis will deal directly with questions like this, and will develop simple, consistent, equitable rules concerning the association and timing of all costing elements.

Because this thesis follows in the wake of a number of other clearly developed studies and statistical models, many of their elements will apply here; some will not. In the case of similarity or difference, omission on my part or theirs, specific reasons will be stated in the Comparative Analysis found in each sub-category. Major findings will be recapitulated in the concluding chapter.

As introduced previously, this study will develop and apply the costing model using data collected that represents actual force behavior. This thesis diverges from the focus of previous studies by applying the model as closely as possible to units assigned to the Naval Reserve and a sampling of their active duty counterparts. The theoretical consistencies presented by others and proposed herein will be tested with the data from ships that have actually

operated in the active and reserve environments. To this end, the following ships were selected for study and comparison:

1. FFG-7 Class

- a. NRF:     USS WADSWORTH (FFG-9)  
              USS DUNCAN (FFG-10)
- b. AD:       USS JARRETT (FFG-33)  
              USS CROMMELIN (FFG-37)

2. FF-1052 Class

- a. NRF:     USS GRAY (FF-1054)  
              USS LANG (FF-1060)
- b. AD:       USS MEYERKORD (FF-1058)  
              USS REASONER (FF-1063)

Each of these ships currently operates in the U. S. Pacific Fleet, all with homeports (with the exception of Meyerkord and Reasoner) in Long Beach, California. The remaining two units are homeported in San Diego, California.

Selection of these units was made on the basis of unit similarity by ship type and homeport location, while the general operating schedules of each were considered so as to be representative of force behavior within each organization.

## 1. Ship Type

A critical element in establishing the survey population was to find ships whose manning and equipment were generally the same from one unit to the next. This issue was particularly important from the start, since the manning required to maintain and operate the ships, either within the organization or at a depot level<sup>2</sup>, is closely associated with the ship's equipment. Because the backbone of the Naval Reserve Force consists of FF-1052 and FFG-7 class frigates, two AD ships of each of these classes were selected for inclusion in this survey.

## 2. Homeport Location

For a variety of specific reasons it is more convenient to select units for comparison that are geographically colocated in their homeports. While the Navy enjoys uniformity in many costs and operations, the incidence of differences in costs is pervasive, nevertheless. NRF ships assigned to the Pacific Fleet are presently homeported in Long Beach,

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<sup>2</sup>The terms 'organizational-level' and 'depot-level' are two specific and important categories in both active duty and reserve ship maintenance and operation. The organizational-level of operations and maintenance (O&M) is that work which is conducted by personnel assigned to the ship's crew. Depot-level maintenance is that which is conducted by organizations distinctly separate from the ship, with a 'moderate' repair and overhaul capability. Repair ships, destroyer tenders, and Shore Intermediate Maintenance Activities (SIMAs) fall into this category.

while active duty frigates have homeports as divergent as Yokosuka (Japan), Pearl Harbor, San Diego, and Long Beach. Supplemental costs for personnel travel, fuel, parts, and supporting personnel (among many others) would be introduced by selecting units with widely separated homeports, and may not be wholly isolated and accounted for as such.

The costing model developed here has three principle qualities in mind: pertinence, comprehensiveness, and flexibility. An extraordinary number of factors may come into play when attempting to develop an organizational cost analysis; some are specifically related to the issue, while some appear as tangents to the problem. As these tangential issues are considered, we find that costs begin to merge with costs that originate with organizations outside of the survey group. Costs must be consistently isolated ("segmented") for all ships, to gain a true understanding of the differences that are manifested by each organization's policies.

To counter the issue of pertinence is the equally critical element of comprehensiveness. Including too few costing elements may be as troublesome as including too many. With this in mind, we then ask "Are all costs that form part of the frigate's operation and maintenance

included?" If not, it then becomes important to locate and isolate that which is missing.

Flexibility is important because it may prove useful in the future for researchers to compare these techniques, data sources, and conclusions with their own findings. This study is designed to provide a useful guide for the researcher who, five or ten years from now, wants to evaluate conditions as they then exist. Data has been collected from unclassified sources available from the commands cited in each costing category; that which has not been transferred directly to the unit cost summary has been thoroughly refined in the Thesis Costing Technique section found in each sub-category.

This thesis captures the costs that were observed in Fiscal Year 1986 (October 1985 to September 1986) and uses values adjusted to FY 1986 dollars.<sup>3</sup> The uniqueness of the time period and frigates involved means little however; this is a sample study that can be duplicated with a similar group and (barring major policy changes) with the same data elements.<sup>4</sup>

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<sup>3</sup>Consumer Price Index values provided by Whitney Culbertson, OPNAV Economic Analysis Branch (OP01B3): 1984 - 3.5%; 1985 - 3.6%; 1986 - 0.7%.

<sup>4</sup>Susan J. Bodilly, Richard Y. Pei, and John F. Schank, Unit Cost Analysis: Annual Recurring Operating and Support Cost Methodology (Santa Monica, Ca.: The Rand Corporation, 1986), pp. 4-5.



The units selected for inclusion in this study are similar in type and operating behavior with the majority of the ships in their class and organization. Eight ships were selected to be able to make comparisons of results at the level of collection and analysis; the results would prove meaningless if the resulting values could not be applied to the five-score ships of the active frigate force that might have been chosen. To this end, the model seeks to be a universal one that may be subject to future use and improvement.<sup>5</sup>

#### D. SCOPE OF CURRENT COSTING STUDIES

A number of studies have been conducted in recent years to estimate the costs associated with ship unit operations in the Navy's surface warfare and aviation communities. These studies have provided some answers for questions that have arisen between Congress and the Pentagon regarding the needs, costs, and merits of the active and reserve naval forces.

Studies evaluated by this thesis range from the purely theoretical to those that have solid accounting foundations.

1. Unit Cost Analysis: Annual Recurring Operating and Support Cost Methodology

This paper stands as the primary contemporary reference in comparative unit costing for active duty

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<sup>5</sup>Bodilly, Pei, and Schank, p. 6.

and reserve units in the Navy, Air Force, and Army. It treats the Navy's manning problem in some detail; it focuses on the numbers and resulting costs derived from individual manpower authorizations of two FF-1052 class frigates, and from force-wide averages for additional manpower costing data, equipment, maintenance, and operating costs. Cost figures cited from this work are in FY 1983 dollars.

2. Personnel Costs of Navy Active and Reserve Forces

This study focuses exclusively upon average force personnel costs. Specific average allowance values are generated in FY1985 dollars.

3. Visibility and Management of Operating and Support Costs - Ships (VAMOSOC)

Compiled by the Naval Sea Systems Command (NAVSEA 017E2). A two-volume reference work published annually, the VAMOSOC incorporates accounting data from a variety of Navy sources to provide a standard list of summarized costs for all active duty ships. NRF ships and their associated values are not included. Costs that are not immediately attributable to the ship (either because of timing or location) are also not included. The time period that each edition of the VAMOSOC covers is the pertinent fiscal year; dollar figures reported are current for the published date of the VAMOSOC.

#### 4. Navy Program Factors Manual

A product of the Office of the Chief of Naval Operations, the NPFM was developed to provide a broad estimate of the costs in money and manpower required to operate ships and aircraft. Factors were derived by using the Navy Resource Model (NARM) and drawing from data available in the Five Year Defense Plan and the Program Objective Memorandum (POM). Both direct and indirect costs were computed in FY 1982 dollars. Use of the figures in the NPFM generates values that are applicable to ship and aircraft types for general planning purposes.<sup>6</sup> Because this analysis pre-dates the transfer of the first frigates to the Naval Reserve Force, no useful values pertaining to the NRF units are available here.

#### 5. Frigate Maintenance Man-Hours Comparisons

Using the FY 1983 VAMOSC, Center for Naval Analyses researchers compared man-hours reported as being used for organizational- and intermediate-level maintenance by AD and NRF FF-1052 class frigates. Data was aggregated for ships in the Atlantic and Pacific Fleets. This study is particularly interesting in its treatment of maintenance personnel costs.

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<sup>6</sup>Office of the Chief of Naval Operations, Navy Program Factors Manual (Washington, D.C.: U.S. Government Printing Office, 1980), pp. 2-3.

6. Enlisted Accessions of Navy Veterans to the Selected Reserve

This statistical study of Navy veterans of 51 ratings employed probit analysis to identify those significant factors that would positively and negatively affect affiliation with the Selected Reserve after completion of the active duty obligation.<sup>7</sup>

7. Economic Analysis Report

A product of "The Assessment Group" (on contract to OP-162), this statistical analysis provides detailed information concerning specific average costs for each of the rates and ratings of Navy personnel. Values cited are in FY 1984 dollars.

E. FRIGATE MANNING AND OPERATIONS

Active duty and Naval Reserve units have a combination of full- and part-time personnel assigned to them. In the case of the active duty ships, the crew is predominantly composed of full-time personnel, with a small selected reserve detachment assigned for duty in the event of mobilization. The Selected Reserve (SELRES) detachment typically conducts monthly Inactive Duty Training (IDT) drills on weekends at its hometown Naval Reserve Center,

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<sup>7</sup>Aline O. Quester, Enlisted Accessions of Navy Veterans to the Selected Reserve (Alexandria, Va.: Center for Naval Analyses, 1983), p. 5.

with annual Active Duty Training (ACDUTRA) of two weeks' duration held onboard the ship.

Organizational corrective maintenance is completed by the active crew; the majority of organizational preventive maintenance is likewise allocated for active crew accomplishment. SELRES participation in maintenance activities is usually designed to reacquaint the Reservist with facilities, the Preventive Maintenance System, and the equipment through "hands-on" training.

Readiness conditions inport and at sea are routinely within the grasp of the active duty crew, which typically maintains Watch, Quarter, and Station assignments for all watch conditions from readiness for immediate combat (General Quarters), through normal protracted steaming (Watch Conditions III and IV), and Emergency Bills. The SELRES detachment is intended to supplement the active crew for protracted combat readiness while underway. In fact, while the detachment does provide some relief in numbers and ratings for underway steaming, their numbers are too few, with too little organizational experience to dramatically change any existing watch assignments. This point is worth emphasizing; the SELRES detachment assigned to each AD ship may come to play a critical role in the event of a protracted military campaign. For the purposes of this thesis however, the AD SELRES detachment is discounted because their participation in the full range of AD unit



activities (short of planned war mobilization) is not significant. For this reason, the costs of AD unit SELRES manpower are not included in unit manpower costs.

Active duty unit operations dwell on preparation for and periodic execution of fleet exercises, special operations, and major overseas deployments of six-seven months' duration. Within the thesis survey group, three AD ships (Jarrett, Crommelin, and Meyerkord) operated exclusively in the Eastern Pacific during FY 1986; the fourth (Reasoner) participated in a Western Pacific-Indian Ocean deployment during this time.

Reserve ship manning consists of a combination of Regular Navy, full-time active Naval Reserve (TAR)<sup>8</sup>, and SELRES personnel. Congress has mandated<sup>9</sup> that no more than fifty percent of the crews for NRF ships would be composed of full-time personnel, which would consist exclusively of TAR reservists.<sup>10</sup> To date, the Navy has not been able to assign personnel in a manner that would retain these units in combat and material readiness because:

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<sup>8</sup>Training and Administration of Reserves. TAR personnel are full-time reserve officers and enlisted that serve on active duty. Their charter is to assist in the administration, recruitment, and training of the Naval Reserve organization.

<sup>9</sup>Office of the Chief of Naval Operations, A Report to the Congress on the Navy's Total Force, (1984), p. D-3.

<sup>10</sup>Office of the Chief of Naval Operations, A Report to the Congress on the Navy's Total Force, (1985), pp. III 24-25.

1. A shortage of TAR officers qualified for surface warfare duty exists.
2. Selected Reservists have not been on active duty sufficiently to obtain certain qualifications available only through lengthy service school programs.
3. TAR career progression within certain skill groups have not yet been fully developed.<sup>11</sup>

As a result, full-time manning has been a mix of both active duty and TAR personnel. Since 1982, the Navy has taken positive steps to broaden TAR career opportunities. Likewise, the qualifications programs for some skills have been "modularized" in a manner that allows Reservists to continue their technical training when their drill periods occur.

A substantial portion of the remaining crew vacancies are allocated to Selected Reservists for manning during their drill periods and ACDUTRA.

Two additional initiatives exist that improve both Reserve and unit readiness. First, recent Navy policy changes have caused at least two independent Naval Reserve Centers to be contributors to NRF ship manning. The original SELRES crew was redesignated as the primary crew; manning

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<sup>11</sup>U.S. General Accounting Office, The Extent of Navy Compliance with Congressional Guidelines on the Training and Administration of the Reserve (TAR) Program. GAO/NSIAD 85-139, (1985), p. 3.

remained unchanged. A second NAVRESCEN was designated as the alternate crew. This detachment is to exercise one drill per quarter and annual ACDUTRA onboard the NRF ship, at a time that does not coincide with the training of the primary crew. Either SELRES crew may be designated as the pre-crew for a new unit joining the NRF, thereby providing a base of corporate experience in rapidly adjusting the command to NRF operations.<sup>12</sup>

Organizational maintenance onboard NRF ships is completed jointly by the assigned full-time crew (consisting of active duty and TAR personnel), the SELRES designated for assignment, and depot-level personnel specifically designated to accomplish shipboard maintenance.

Unlike active duty ships, the designed sustainability of the NRF unit is limited to 96 hours underway when only the full-time crew is aboard. During those periods in which either the primary or alternate SELRES crew is onboard, operational capabilities are only limited by the duration of the SELRES training period.<sup>13</sup>

Underway operations for the NRF units consist primarily of basic ship drills and underway engineering training. Each of the NRF ships in this survey have had operating schedules

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<sup>12</sup>Office of the Chief of Naval Operations, "Reserve Manning Policies, Naval Message DTG 231926Z May 1985." (Teleprinted.)

<sup>13</sup>Office of the Chief of Naval Operations, "Reserve Manning Policies, Naval message DTG 231925Z May 1985." (Teleprinted.)

during FY 1986 that included special operations, fleet exercises, and (in all but one case) overseas port visits.

#### F. INTRODUCTORY COMMENTS

While the cost accounting and manpower analysis addressed in this thesis are designed to provide a compact, effective analytical device for ship costing, the paper also tries to link the policies of the Navy in the costing evaluation.<sup>14</sup> To accomplish this, specific unit costs are used whenever possible, rather than force averages. The strength of this costing approach is that it highlights the real costs that have been incurred from actual ship operations during the period.

It should become clear early on that just as the characteristics of the Regular Navy and Naval Reserve Force differ, so to does the manner in which their respective ships are employed. They exist in their present roles for different fundamental reasons. "Force decision mixes must consider both the costs and the wartime capabilities, and the tradeoffs between them. Other important decision variables are the peacetime rotation base, deployment schedules, and legislative constraints. The comparison of annual O & S<sup>15</sup> should not be the sole criterion in mix

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<sup>14</sup>Bodilly, Pei, and Schank, Unit Cost Analysis, p. 2.

<sup>15</sup>O & S: Operating and Support.

decisions."<sup>16</sup> That an AD frigate costs more or less than its NRF counterpart to operate is interesting, but the result holds little significance unless the reader is willing to consider the values of force readiness, force training, and mission compatibility.

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<sup>16</sup>Bodilly, Pei, and Schank, p. 16.



## II. UNIT MANPOWER COSTS

Unit manpower costs presented in this thesis are based upon an analysis of the crews of each of the eight frigates researched in this study. Finding 'manpower costs' is not simply a process of summing accrued wages; begin first by thinking of ship manning that involves active duty and reserve units as being an organizational analysis of six different personnel systems, each of which administers its own compensation system. These six systems separately deal with the officer and enlisted manning programs for USN, TAR, and SELRES organizations.

A fundamental argument presented by advocates of expanded NRF participation in national naval affairs has been that it is substantially less expensive to man an NRF frigate than its AD counterpart. Is it true? This chapter will dissect crew compensation categories and (within the scope of this study) attempt to provide specific answers.

The range of the manpower cost family demands that it be broken down into specific cost categories, which are listed as follows:

- A. BASIC PAY AND ALLOWANCES;
- B. SEA PAY;
- C. UNIQUE NAVAL RESERVE FORCE COSTS;

D. TRAVEL COSTS;

E. RECRUITING AND INITIAL TRAINING COSTS;

F. SELECTIVE REENLISTMENT BONUSES AND ADVANCED TRAINING COSTS; and,

G. RETIREMENT COSTS.

These categories are recurring, direct, and largely fixed in nature.

An issue that should be evaluated before proceeding further is selecting the reference to be used in costing ship manning. There are three widely-used references to chose from: the Manpower (Billet) Authorization, the Navy Manning Plan (NMP) for the ship, and actual values for those present onboard.

The Manpower Authorization (OPNAV 1000/2) is published for each ship, representing a standard manning scheme for ships of the class. Time analysis studies have been used to develop standard values for work and watch-standing, which are reflected through this standard manning plan. The MA is unaffected by actual Navy manning shortfalls or surpluses.

The other extreme is represented by the Officer Distribution Control Reports (ODCR), Enlisted Data and Verification Reports (EPMAC-EDVR-1080), and the NRF Manning Matrix for each ship. These monthly data sheets are transmitted to each command, representing the actual manning (both current and projected) for the ship.

Between the standard and actual values are those presented in the Navy Manning Plan. The NMP is a

distribution estimate (by rate and rating) of sailors for each ship, based upon a "fair share" of the total number of personnel available from each cohort.

The data that is present then, reflects the standard, the "fair share", and the actual manning conditions for each of the ships in the survey, and in the Navy.

The Rand study leads the list of comprehensive works that elect the standard (MA) scheme for unit manpower costing. Unit Cost Analysis notes that the

programmed levels of unit personnel are used to represent the cost of average units and to overcome any personnel constraints due to budget problems. Therefore, the cost estimates assume the absence of unit manpower shortfalls and surpluses.<sup>17</sup>

This thesis takes a contrary view, and uses actual manning levels for two reasons:

1. It focuses the costing problem upon the individuals assigned to the command and not standard manning levels or force-wide averages.
2. It observes deviations from the authorized manpower levels, and explains the reasons or implications.

The Manpower Authorization dictates the "authorized" manning level, but not necessarily the "actual" manning level, which may be substantially different. Analyses that have used force-wide averaging techniques have typically assumed that the manpower authorization document would serve

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<sup>17</sup>Bodilly, Pei, and Schank, p. 5.

as a reasonable guide for actual unit manning levels. This assumption is found wanting, because units rarely enjoy manning levels that duplicate the MA document. They may very rarely be over-manned and are usually the opposite; additionally it is not unusual to find shipboard billets filled by qualified personnel junior in rate to that found in the manning document. Table I reflects this condition as the ship's average allowance (the "standard" value) is compared with the average number of personnel actually assigned.

Because detailed data references are not available in all categories of this ex post analysis, standard or force-wide references may be required. Whenever possible though, this thesis will employ actual manning documents to develop a finely-focused analysis within the survey group.

The pay, allowances, supplementary bonuses, and retirement accruals of active duty, TAR, and Selected Reservists differ substantially from each other. For this reason, the computation of each manpower cost element frequently changes, depending upon the personnel category referred to. The following sections will break down total manpower costs into individual categories and provide substantial background material supporting both the cost computations of other researchers, and the selected technique of this author.

TABLE I<sup>18</sup>

## AVERAGE MANNING: ACTUAL VERSUS AUTHORIZED

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ALLOW = (The sum of monthly personnel allowances) / 12

ONBD = (The sum of personnel observed onboard monthly) / 12

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|                  | USN   |       | TAR   |      | SELRES |       |
|------------------|-------|-------|-------|------|--------|-------|
|                  | ALLOW | ONBD  | ALLOW | ONBD | ALLOW  | ONBD  |
| <b>WADSWORTH</b> | 98    | 103.2 | 20    | 32.5 | 69     | 60    |
| <b>DUNCAN</b>    | 87.6  | 107.3 | 30.4  | 34.4 | 69     | 65.6  |
| Crommelin        | 205   | 206   | 0     | 0    | --     | --    |
| Jarrett          | 205   | 196   | 0     | 0    | --     | --    |
| <b>GRAY</b>      | 80    | 86.1  | 81    | 98.2 | 131    | 100.4 |
| <b>LANG</b>      | 80    | 89.6  | 81    | 99.2 | 129    | 103.1 |
| Meyerkord        | 259   | 255   | 0     | 0    | --     | --    |
| Reasoner         | 266   | 270   | 0     | 0    | --     | --    |

Ships **accented** above experienced average actual manning variances of 10 percent or greater from average standard manning levels prescribed by Manpower Authorizations.

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<sup>18</sup>Earl Wilson, "NRF Monthly Manning Status, Profile, and NEC Attainment," Washington, D.C., 1986. (Photocopied.)



Changes in unit manning resulting from equipment modifications or personnel policy alterations are considered to be a part of current organizational behavior and are included to capture in part, the dynamics of the manpower problem.

#### A. BASIC PAY AND ALLOWANCES

Incorporating the individual compensation elements of basic pay, allowance for quarters, and, where applicable, variable housing allowance, this category encompasses the lion's share of the compensation package of the active duty service member. Payment of this salary is made year-round, and entitles the member to payment during 30 authorized days of annual leave.

Among the studies that lead in the evaluation of this category are works by Rand Corporation, the Center for Naval Analyses, and the VAMOSC.

##### 1. Current Studies Costing Techniques

###### a. Rand Study Group

Schank, Bodilly, and Pei used the pay and allowance totals of the Navy Department's Justification of Estimates for Fiscal Year 1984, Military Personnel, Navy<sup>19</sup> and divided by average active duty officer and enlisted strength to develop an average cost per individual in each

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<sup>19</sup>Hereafter referred to as Justifications.

category. The cost per unit was derived by multiplying the result by the officer or enlisted personnel levels cited in the contemporary unit Manpower Authorization Form (1000/2).<sup>20</sup>

In much the same manner as for active duty personnel, the total TAR payroll has been drawn from Justifications, divided by the average total TAR strength, and multiplied by TAR manning as reflected by the Manpower Authorization reports of each command.

Because Selected Reservists draw pay and allowances for only that time in which they are drilling, the uniformity of active duty and TAR payroll estimates is not reflected here. Schank and associates derived an effective means of cost estimation by referring to the USNR Personnel Resources Branch (NOP-09R32) for estimates of costs per drill for IDT periods and costs per day for active duty training.<sup>21</sup>

b. VAMOSC

The VAMOSC includes the basic pay and allowance elements and has also added "other" entitlements and government contributions to FICA and the Servicemen's Group Life Insurance program. In

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<sup>20</sup>Bodilly, Pei, and Schank, Unit Cost Analysis, p. 10.

<sup>21</sup>Bodilly, Pei, and Schank, pp. 111-112.

doing so, it has summed the specific pay figures for each officer and enlisted assigned to the ship during the year and has then reported this value. In effect, the total payroll of the ship has been incorporated in one, all-inclusive value.

Because NRF units are not included in explicit VAMOSC costing (as of FY 1986), there is no measure of the basic pay for the active duty, TAR, or SELRES personnel assigned to these commands.

c. Feldman Study

The Feldman study has calculated costs per officer and enlisted within active duty and TAR ranks, based upon summed values of individual pay and allowances drawn from Justifications. This has then been divided by average force strengths for officers and enlisted personnel.<sup>22</sup>

Costs cited for TAR personnel in the reference included both flight and sea pays; neither could be effectively extracted from the overall costs and are uncorrected in the subsequent analysis.

Feldman observed that "TAR pay and allowances factors are higher than those of active-duty personnel because the TAR pay-grade structure is

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<sup>22</sup>Ronald Feldman, Personnel Costs of Navy Active and Reserve Forces (Alexandria, Va.: Center for Naval Analyses, 1985), p. 3.

skewed towards the higher grades".<sup>23</sup> (This statement will prove particularly important as the thesis investigates the average compensation of crewmen on each of the survey ships.)

The Feldman analysis noted that SELRES pay and allowance factors in Justifications were tainted with the average retirement contribution of all Navy personnel. While more will be said about the actuarial nature of the retirement system, Feldman extracted the retirement factor entirely to obtain a total pay value for SELRES personnel. This value was then divided by average strengths to find a cost per SELRES officer and enlisted.<sup>24</sup>

## 2. Thesis Costing Technique

As has been mentioned already, this costing sub-category has been particularly interesting in developing a working methodology for because it has demanded an understanding of and data for six inter-related pay schemes.

No one source in the Navy exists to identify the total pay and allowances for the Regular, TAR, and SELRES sailors of a selected ship. Worse still, many authorities that hold data are unable to tell the researcher which of these personnel categories are

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<sup>23</sup>Feldman, p. 6.

<sup>24</sup>Feldman, pp. 4-5.

included in their data base, whether the data represents base pay alone (or with allowances), or whether the data includes direct disbursements only or electronic funds transfers as well. This is not to imply that these diligent personnel are unaware of what they control; rather, since the pay schemes are inter-woven so closely, it is difficult to isolate and validate the presence or absence of any given category of sailors.

This thesis used two independent data sources to provide information relating to the Regular Navy and TAR pay and allowances. The first source was a cumulative pay and allowances summary provided by the Finance/Comptroller Department of the administrative ("Type") commander of these ships.<sup>25</sup> The second reference was a "snapshot" of total active duty pay and allowances provided by the Navy Finance Center (NAVFINCEN).

Costing for the SELRES detachment of each NRF ship followed a different path. Selected Reservists receive base pay on a scale equivalent to that of their Active Duty counterparts, which is structured around the pay grade and time-in-grade of each sailor and officer. SELRES are only paid on the basis of

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<sup>25</sup>Commander, Naval Surface Forces Pacific, referred to hereafter as COMNAVSURFPAC.



their drill time; each four hour drill completed yields one day's base pay. Four drills are typically conducted during each weekend Inactive Duty Training period; these, in turn, are conducted twelve times each year.

The participation rate reflects the average value of "regular" and "equivalent training" drills cited on unit Naval Reserve Drill Pay Earnings Statement Reports. Add to this the 14 days of base pay received as a result of participating in the two-week annual ACDUTRA, and the sum is the base pay received by the individual reservist each year. Figure 1 steps through this costing process.

Using this as a guide, the thesis used the Reserve Manning Matrices of each NRF frigate to identify the appropriate pay scale of all participating reservists.

### 3. Data

This category includes the base pay, allowances, entitlements, and contributions to FICA and SGLI for all personnel assigned to each of the commands in the survey. Sources of

data for Regular Navy and TAR personnel were COMNAVSURFPAC and NAVFINCEN. Cumulative values for each NRF SELRES detachment were calculated using the technique noted above, and are included in the

$$\begin{array}{r}
 \text{-----} \\
 48 \text{ paid drills per year (48 days base pay)} \\
 + \\
 \text{Annual Active Duty Training (14 days base pay)} \\
 = \\
 62 \text{ days base pay} \\
 \times \\
 \text{Average Participation Rate (0.89)} \\
 = \\
 \underline{55.2 \text{ days base pay per SELRES per year}} \\
 \\
 55.2 \text{ days} / 30 \text{ days per month} = 1.84 \text{ months pay per year} \\
 \times \\
 \text{Average Monthly SELRES Payroll} \\
 = \\
 \underline{\text{UNIT SELRES ANNUAL BASE PAY}}
 \end{array}$$

Figure 1: SELRES Annual Base Pay Calculation

following totals. Also included are SELRES detachment sea pay values referred to in the next sub-category.

Unit Pay and Allowances (FY 86 dollars)<sup>26</sup>

|            |           |            |           |
|------------|-----------|------------|-----------|
| Wadsworth: | 3,163,538 | Crommelin: | 4,172,820 |
| Duncan:    | 3,577,972 | Jarrett:   | 4,530,765 |
| Gray:      | 4,942,122 | Meyerkord: | 5,050,459 |
| Lang:      | 5,060,846 | Reasoner:  | 5,343,083 |

4. Comparative Analysis

One of the fundamental arguments favoring the expansion of the Naval Reserve Force has been that the economies resulting from the transfer of active duty billets to the reserves would yield enormous savings in the manpower account. The results illustrated here indicate that the savings may be more modest than anticipated.

There are two principal factors that appear to have contributed to the escalation of NRF manning costs during FY 1986:

1. While the AD ships have manned at levels very close to their standard manning rates, NRF units were substantially over-staffed with active duty personnel throughout the year.

Using data from Table I, the following percentages

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<sup>26</sup>Values have been averaged and transferred to the Unit Cost Summary on page 178.

represent the average active duty manning levels of each of the NRF survey ships:

|            |       |
|------------|-------|
| Wadsworth: | 115   |
| Duncan:    | 120   |
| Gray:      | 114.5 |
| Lang:      | 117.3 |

Active duty personnel represent expensive human assets, which is reflected here by a substantial increase in each ship's total pay and allowances. Interestingly, it should be noted here that studies that use standard manning levels for unit personnel costing would not be able to detect this, or many of the following specific costing deviations that actually occur.

2. Manning individual active duty billets onboard NRF units is at least as costly as manning the billets of the AD ship. To dramatize this statement, consider the average annual total of pay and allowances for each ship's billet:

|            |          |
|------------|----------|
| Gray:      | \$23,812 |
| Lang:      | \$23,217 |
| Jarrett:   | \$22,101 |
| Duncan:    | \$20,339 |
| Crommelin: | \$20,159 |
| Wadsworth: | \$19,513 |

Meyerkord: \$18,432

Reasoner: \$18,298

More than \$5500 separate the highest average pay from that of the lowest. More noteworthy still is the fact that the labor intensive FF-1052 class is split, by organizations, at the extremes; the implication here is that while the rating profiles of the corresponding ships are similar, the time-in-grade (and resulting pay levels) of the average sailor assigned to the billet are skewed in favor of the NRF units. Although data is not available here to substantiate this hypothesis, Feldman's earlier findings--that TAR pay exceeds that of the Regular Navy counterpart--may well be accurate through contribution to a higher average crew pay.

The studies by Rand and CNA have perhaps greater application in a predictive force-wide model, where using average values may more surely reflect the characteristics of the force as a whole, or where collecting specific unit values may prove ungainly. For the purposes of a small survey population, the discoveries that result from an intimate analysis of the behavior of individual ships and personnel groups appear to make the endeavor worthwhile.



## B. SEA PAY

Career sea pay is a supplementary allowance authorized to personnel assigned to sea duty, recognizing the arduous nature of this activity. Active duty and TAR personnel are entitled to this pay while assigned to the ship, as are Selected Reservists while conducting active duty training onboard either AD or NRF units.<sup>27</sup> Selected Reservists do not receive sea pay while conducting regular or additional drills.

While this thesis includes the costs of sea pay in the Basic Pay and Allowances sub-category, treatment of the topic as a separate entity by other references merits specific attention here.

### 1. Current Studies Costing Techniques

#### a. Rand Study Group

The Rand group arrived at their cost for active duty sea pay by isolating the total allowance for officers and enlisted found in Justifications, and dividing by the average manning strength of each group within the year.

Rand has not isolated sea pay costs for TAR personnel. This cost has been integrated with the total budget allocated for TAR pay and allowances

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<sup>27</sup>Herbert A. Bartholomew and Robert R. Morris, Military Compensation Background Papers: Compensation Elements and Related Manpower Cost Items (Washington, D.C.: U.S. Government Printing Office, 1982), pp. 144-145.

for officers and enlisted, which has then been divided by total TAR strength for the year to obtain an average value of compensation<sup>28</sup>.

Sea pay contributions to Naval Reservists have been found by multiplying average costs per day (provided by the USNR Personnel Resources Branch (NOP-09R32)) by 14 (representing total days of annual shipboard training) and then by the observed participation rate (again provided by the USNR PRB).

b. VAMOSC

This document included the sea pay category within its summary cost expression (elements 1.1.1.2 and 1.1.1.3) derived from the Joint Uniform Military Pay System (JUMPS)<sup>29</sup> for active duty frigates crews only. NRF unit crews have not been considered by this document. As a result, the VAMOSC has little value in this comparative analysis.

c. Feldman Study

An average sea pay for active duty personnel was developed using the summary cost of AD sea pay

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<sup>28</sup>Bodilly, Pei, and Schank, Unit Cost Analysis, pp. 115-116.

<sup>29</sup>Commander, Naval Sea Systems Command (NAVSEA 017E2), Visibility and Management of Operating and Support Costs - Ships, 2 vols., (Washington, D.C.: n.p., 1986), pp. A 5-6.

from Justifications and the total number of sea-rated officers and enlisted personnel in the Navy.<sup>30</sup> TAR sea pay costs are incorporated in the average cost figure that was derived for TAR pay and allowances.<sup>31</sup> Estimated per-capita sea pay values for the Selected Reserve elements were obtained directly from OP-09R.

d. Economic Analysis Report

This analysis provided an average value of sea pay distributions to personnel, with each estimate classified by rate, rank, and rating.

2. Thesis Costing Technique

Sea pay was incorporated with the Regular Navy and TAR basic pay and allowance calculations completed in the previous sub-category.

SELRES personnel are eligible for career sea pay when performing active duty training only; as a result, for their 14 days of training each year, the monthly rates payable<sup>32</sup> are multiplied by 0.46667 (representing 14 of 30 days). Participating SELRES personnel have been identified from the NRF Manning Matrix, and the resulting sea pay calculated from

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<sup>30</sup>Feldman, Personnel Costs, p. 6.

<sup>31</sup>Feldman, p. 6.

<sup>32</sup>Commander, Navy Military Personnel Command, Administrative Procedures for Naval Reservists on Inactive Duty, BUPERSINST 5400.42F, (1986), p. V-1-4.

this information. Individual SELRES sea pay computations have been summed and included with the basic pay and allowances reflected in the previous sub-category.

Selected Reserve Sea Pay Estimate (FY 86 dollars)

|            |      |       |      |
|------------|------|-------|------|
| Wadsworth: | 3049 | Gray: | 5818 |
| Duncan:    | 3347 | Lang: | 5818 |

3. Comparative Analysis

Leading analyses rely upon force averages to provide a sea pay appropriate for the individual sailor. Their techniques differ slightly: the Rand study group used Navy-wide averages and cumulative sea pay disbursements to produce an average value. This may generate a figure that is lower than that actually received by active duty personnel, because only a portion of all Navy officers and enlisted serve at sea (and receive the appropriate pay) at any one time. The Feldman study appears to close in on an accurate active duty sea pay average by focusing on personnel qualified for sea duty; again, not all personnel that are eligible for sea duty were actually serving and being paid for it in 1986.

The VAMOSC provides sea pay data for active duty units as provided by those units to the Navy Finance

Center; as an archival tool, the VAMOSC appears to have the best accuracy. Unfortunately, the scope of this study does not include the NRF units. As an analytical tool, the Economic Analysis Report appears to have a sound base, using historical sea pay disbursements by rate and rating to develop an individual pay value for each cohort.

### C. UNIQUE NAVAL RESERVE FORCE COSTS

This costing sub-category applies only to NRF units, and deals exclusively with specific manpower issues unique to these ships which create other additional personnel costs that have not yet been considered by this thesis.

An "additional cost" element develops when the SELRES detachment is called upon to perform additional paid drills in excess of the number mandated as part of normal annual training.

"The primary purpose of an additional drill is to provide the opportunity to obtain required training for mobilization readiness which cannot be accomplished with regular scheduled annual drills."<sup>33</sup> Under this charter, the primary, alternate, and precrews of NRF ships are authorized to exceed the 48 paid drills scheduled for each year, in order to take advantage of special training opportunities

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<sup>33</sup>Commander, Navy Military Personnel Command, Administrative Procedures, p. III-1-A-1.



and to achieve required skill qualifications.

If the unit Commanding Officer considers it necessary, SELRES personnel assigned to the primary detachment may be called upon to report for up to 30 additional drills. Precrew and alternate crew personnel may receive pay for 4 additional drills during the year.<sup>34</sup> Because of the substantial costs that arise from conducting each additional drill, the ship must demonstrate a correlation between need for the training and its timing outside of the regular drill schedule.

## 1. Current Studies Costing Techniques

### a. Rand Study Group

The Rand group costed additional drills by separately calculating the average cost of base pay for officers and enlisted assigned to NRF units. This value was then multiplied by the number of personnel in the detachment and then by the historic participation rate of the detachment for regular drills. This product was then multiplied by 30, the maximum number of additional drills permissible for the primary detachment for the year.

## 2. Thesis Costing Technique

The Naval Reserve Drill Pay Earnings Statement Report is an automated monthly summary expense sheet

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<sup>34</sup>Commander, Navy Military Personnel Command, p. III-1-A-3.

provided by NAVFINCEN to each SELRES detachment, citing the number of drills (by category) that each reservist participated in during the preceding month, and the appropriate disbursements that each received. For the data used by this thesis, Earnings Statement Reports were sampled to identify the average number of additional drills per unit and the average pay received by participants during each additional drill. These values were then multiplied by the average SELRES detachment strength of each unit to provide the values noted in the model below.

#### Unique NRF Costs<sup>35</sup>

| Unit      | SELRES<br>Crew | Additional<br>Pay/Drill | Additional<br>Drills | Total<br>Add'l Pay |
|-----------|----------------|-------------------------|----------------------|--------------------|
| Wadsworth | 60             |                         |                      | 40,240             |
| Duncan    | 65.6           | x \$66.60               | x 10.07              | = 43,995           |
| Gray      | 100.4          |                         |                      | 67,334             |
| Lang      | 103.1          |                         |                      | 69,145             |

### 3. Comparative Analysis

Within the boundaries of this thesis survey group, several interesting observations have emerged concerning the cost of additional SELRES drills:

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<sup>35</sup>Values have been averaged and transferred to the Unit Cost Summary on page 178.

1. The costs are non-trivial. The average pay disbursement for each reservist for each additional drill was \$66.60.
2. Actual attendance at additional drills ranged from the minimum (zero) to the maximum permissible (30) within the detachments. There was a tendency for senior personnel to attend substantially more drills than junior personnel, which contributed significantly to the high average drill costs noted above.

With no data sources available at the headquarters level to isolate these "additional" drills costs, the best source of information remains the Earnings Statement Reports used here. Each provides explicit data on pay disbursements and drills performed by each sailor.

A troublesome aspect of the Rand calculation is that while it may hold accurate for the large number of reservists considered force-wide, it is unlikely that it will accurately reflect the specific training policies of the individual SELRES detachments. Neither does it take into account the higher absentee rate that accompany additional drill periods, which were observed here. Remember that reserve duty is a 'moonlight' activity--not the principal occupation--of the Reservist. Additional

drills may be scheduled on short notice, and as a result may interfere with the professional or personal interests of the Reservist.

The Rand analysis of additional drill costs has two liabilities when applied to this survey: in general, costs of additional drills are maximized (perhaps unnecessarily) and in this specific case, the average costs that are derived do not necessarily reflect the behavior of each SELRES detachment or the parent NRF command.

The general problem arises from the fact that the Rand calculations cost both SELRES officers and enlisted for the maximum number of additional drill days permissible (30) and at a participation rate that the study itself admits may be inordinately high.<sup>36</sup> To illustrate this problem, let us use the sample reserve officer found in the Rand study, who participates in 99 percent of all 30 additional drills. The resulting cost of this officer's services for one year are as follows:

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<sup>36</sup>Bodilly, Pei, and Schank, Unit Cost Analysis, pp. 114-115.

|            |   |               |   |               |   |             |
|------------|---|---------------|---|---------------|---|-------------|
| COST PER   |   | PARTICIPATION |   | ADDED         |   | COST PER    |
| <u>DAY</u> |   | <u>RATE</u>   |   | <u>DRILLS</u> |   | <u>YEAR</u> |
| \$83.47    | x | .99           | x | 30            | = | \$2479      |

What happens if this officer more realistically participates in 60 percent of 5 additional drills? The annual value becomes:

|         |   |     |   |   |   |       |
|---------|---|-----|---|---|---|-------|
| \$83.47 | x | .60 | x | 5 | = | \$250 |
|---------|---|-----|---|---|---|-------|

The result is a cumulative annual cost that is only 10 percent of the projected cost.

The point to be made here is that both the number of authorized additional drills and the absentee rate for these drills figure significantly in the total annual costs in this sub-category. While the ideal solution here is to sum additional drill payments for the crew, a very good alternative exists when the rank/rate profile, average participation rate, and number of additional drills of FY 1986 for each SELRES detachment are known.

Because the scope of the Rand study is force-wide, deriving an average cost value is reasonable and should be accurate. The scope of this thesis is



such that the available information on individual SELRES crew strength, absenteeism, and training programs results in a much more accurate solution.

#### D. TRAVEL COSTS

Travel costs refer to the costs associated with moving military personnel to and from their duty stations for accession, training, rotation, and separation.\_

Within this cost analysis, there are three general categories that will be evaluated: the cost of transferring full-time personnel from another assignment location to one of the frigates in the survey (Permanent Change of Station, or PCS); the expenditure of funds allocated for shipboard personnel to travel afield for official business (Temporary Additional Duty, or TAD); and the funds required for Selected Reservists assigned to NRF units to attend ship's drills and training activities.

These costs include those involved with the physical movement of the crewmember (for PCS and TAD moves) and for their dependents and personal effects (as is the case with PCS moves). Among the costs that arise in transferring the individual with PCS are per diem reimbursements for personal and dependent travel, private vehicle shipment, temporary lodging, and movement of household goods.

PCS moves are an inherent part of the career of the active duty and TAR servicemember. Costs are incurred in

transferring the sailor from the recruiting location to the training command upon accession, and to the home of record upon completion of obligated service. In between, the costs that arise for travel to the unit, to supplementary training schools, to subsequent shore duty assignments or ships, and for changes of the unit's homeport all contribute to the costs associated with this sub-category. All costs are considered in the Navy-wide Permanent Change of Station data found in Table II.

The TAD costing sub-category includes general expenses incurred as a result of travel and lodging used, incidental to specific administrative or training missions in support of the command at a location remote to the ship. The activities that result in TAD assignment (and appropriate compensation for expenses incurred) include participation in Navy training programs, factory-sponsored equipment schools, conferences, meetings, and in selected instances, for individual transportation home when a death in the immediate family occurs.

The costs of PCS moves are generated by active duty and TAR personnel; all three personnel categories contribute to TAD costs.

#### 1. Current Studies Costing Techniques

##### a. Rand Study Group

The Rand group drew PCS costs from Justifications and divided by average force strength to obtain an

TABLE II  
PERMANENT CHANGE OF STATION DATA<sup>37</sup>

|                            | Number of<br>Moves | Average<br>Cost |
|----------------------------|--------------------|-----------------|
| Accessions                 | 102,821            | \$736.37        |
| Separations                | 83,825             | \$817.41        |
| Training                   | 36,346             | \$1916.94       |
| Operational                | 50,375             | \$2858.20       |
| Rotational                 | 38,513             | \$5436.40       |
| Unit moves                 | 7,051              | \$3471.42       |
| Total Moves                | 318,931            | --              |
| Composite Average Costs    | --                 | \$1855.38       |
| Net of Unit Moves          | (7,051)            | --              |
| Adjusted Total and Average | 311,880            | \$1818.84       |

average cost of personnel travel.<sup>38</sup> TAR travel was also taken from Justifications, and then divided by overall TAR strength to derive an average TAR travel value.

In much the same manner as for the TAR community,

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<sup>37</sup>U.S., Congress, House, Subcommittee of the Committee on Appropriations, Military and Civilian Manpower and Compensation Programs. 99th Cong., 2nd sess., 1986, p. 399.

<sup>38</sup>Bodilly, Pei, and Schank, Unit Cost Analysis, p. 116.

Rand drew total travel values for reservists from Justifications and averaged for the total reserve strength.

b. VAMOSC

This document summed costs of travel, allowances, per diem, and additional miscellaneous charges for AD units under the heading of TAD expenses, without isolating costs of PCS movement.<sup>39</sup> (PCS costs are viewed by VAMOSC as being extraordinary costs unassociated with the individual active duty command.) No costs related to NRF travel are noted.

2. Thesis Costing Technique

Research done directly with the PCS Budget Cost Branch (NMPC-712) indicated that the total FY 1986 budget for active duty PCS moves (including the movement of household goods) was \$568,536,000. Using this figure, the adjusted average value for PCS moves was \$1822.93. This secondary source confirms the adjusted average (from Table II) to be an accurate measure for individual PCS moves.

The PCS costing calculated in this thesis uses appropriate Enlisted Data Verification Reports and Officer Distribution Control Reports to identify

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<sup>39</sup>Commander, Naval Sea Systems Command (NAVSEA 017E2), VAMOSC, p. A-7.

full-time enlisted personnel and officers joining individual commands in FY 1986. The sum of these figures is then multiplied by \$1820 to produce an average cost of PCS tailored for each frigate.

This thesis explores the problem of PCS and TAD costing from two separate tangents. For PCS costing, the number of service-wide moves observed in FY 1986 was identified by category and averaged. This value has then been multiplied by the average number of active duty personnel assigned to each command.

The limited survey size of the thesis has allowed specific costs to be drawn from the Type Commander (COMNAVSURFPAC) for TAD travel, for both active and reserve units. This data is listed in Table III.

TABLE III

TEMPORARY ADDITIONAL DUTY TARGET (TADTAR) FUNDING<sup>40</sup>

|            |          |            |          |
|------------|----------|------------|----------|
| Wadsworth: | \$10,050 | Gray:      | \$24,700 |
| Duncan:    | \$18,350 | Lang:      | \$17,300 |
| Jarrett:   | \$28,310 | Meyerkord: | \$8,995  |
| Crommelin: | \$34,525 | Reasoner:  | \$15,847 |

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<sup>40</sup>Commander Naval Surface Forces Pacific, "FY 85 and FY 86 OPTAR and TADTAR Study for Ship Class - FF and FFG," and "Prospective CO/XO Brief Sheets," San Diego, Ca., 1986.



Providing the solution for the total travel budget of each ship, by class and organization, was done by computing the unit PCS value for 1986, and then adding to this the TADTAR of each ship:

TABLE IV  
TOTAL TRAVEL COSTS

$$\begin{array}{rcl}
 \text{Average PCS Cost} & \times & \text{Number of Arrivals in FY 86} \\
 & + & \text{TAD Travel Costs} \\
 & = & \text{Total Unit Travel Costs}^{41}
 \end{array}$$

|             | AVG NUMBER | PCS COST | TAD COST | TOTAL   |
|-------------|------------|----------|----------|---------|
| AD FF-1052  | 113.5      | 206,570  | 12,421   | 218,991 |
| NRF FF-1052 | 100        | 182,000  | 21,000   | 203,000 |
| AD FFG-7    | 72         | 131,040  | 31,417   | 162,457 |
| NRF FFG-7   | 72         | 131,040  | 14,200   | 145,240 |

### 3. Comparative Analysis

The differences that lie between other analyses and this thesis include:

- a. The thesis explicitly cites household goods shipment as a costing element included in the costing model; the Rand study does not.

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<sup>41</sup>Values transferred to the Unit Cost Summary on page 178.

b. The thesis averages based upon observed AD, TAR, and SELRES strengths in each unit, with the ODCR, EDVR, and SELRES training matrices of each unit as guides. The Rand study finds total unit costs in this category based upon the values in the appropriate MA document.

c. Actual TAD costs for each unit are cited in the thesis; average values are used by other sources.

The study that seeks to analyze the costs associated with travel costs for assigned personnel almost immediately becomes involved in the compromise of the accuracy that it always seeks to retain. The reasons and instances in which government travel take place are myriad. Table II lists only the categories for PCS moves; many other specific reasons besides those identified here exist for TAD travel.

Fortunately, the funding associated with TAD travel is aggregated by the Type Commander by individual units and is cited herein. On the other hand, the author was not so lucky as to find a data management system that classified the 318,931 PCS moves by ship and fiscal year. The average PCS value cited (\$1820), when taken with the number of personnel arriving at each command, should provide a very comfortable approximation. This study benefits from having a manageable sample size, which yielded an average

value at least as accurate as that found in the Rand study for PCS moves.

The data matrices above yield the required individual unit values for the summary cost equation. They have more to say, however:

1. Units assigned to San Diego have substantially lower TAD costs for the year. When corrected for emergency leave cases that occurred overseas, USS Reasoner expended \$7150. This, when coupled with Meyerkord's TAD expenses, resulted in an average TAD cost of \$8072.50. By contrast, the average cost of TAD travel for Long Beach units was \$22,206. Clearly, the San Diego-based ships benefited from their proximity to training facilities and major Pacific Fleet commands.

While this is not the forum to evaluate the dispersed homeporting scheme for Pacific Fleet units, it is reasonable to expect that the TAD expenses for both AD and NRF units will remain higher (and perhaps, substantially so) as frigates go further afield to homeports in San Francisco and Everett, Washington.

2. Interestingly, TAD expenses for USS Jarrett and Crommelin were significantly higher than those for the four NRF frigates. The nature of this study is such that this observation cannot be fully

evaluated, but it is interesting to wonder whether there is substance behind these numbers. If all Long Beach-based units were able to maintain satisfactory training levels in FY 1986 with the TAD obligations that they received, then the disposition of Naval Reserve Force ships at the dispersed homeports noted above may show some cost savings over moving their AD sisters.

#### E. RECRUITING AND INITIAL TRAINING COSTS

A generous proportion of the personnel assigned to AD and NRF units are first-term enlistees.<sup>42</sup> While the Navy incurs a continuing expense in paying salaries and allowances for these men (which have already been captured by this model), some costs were generated before their arrival at the command in their recruitment and training.

Each member of the command represents a portion of the ship's total human assets; the costs that the Navy observes in preparing these individuals for naval service then become part of the total cost of frigate operations. To fully develop the costs involved in ship operations for the year then, the costing model must consider expenses incurred outside of both Fiscal Year 1986 and the surveyed commands.

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<sup>42</sup>Officers and enlisted serving under their initial military obligation are hereafter referred to as "first-term" personnel. Those that elect to extend or reenlist are referred to as "career" personnel. Career personnel are dealt with in the next section.

## 1. Current Studies Costing Techniques

### a. Rand Study Group

Rand used unit losses as the basis for active and reserve training costs. The goal in using losses was to "overcome any influences of planned growth in personnel strength".<sup>43</sup> Total active force enlisted and officer losses were divided by total force strength to derive a "turnover rate".<sup>44</sup>

Training cost factors (which include recruiting, basic training, and initial technical training) were derived for a variety of enlisted ratings previously considered<sup>45</sup>. Advanced technical ('C') school costs were not available for this study.

Active officer recruitment and training costs were obtained by multiplying the average number of non-rated<sup>46</sup> officers by the officer turnover rate, and then by multiplying this value by a "ship officer training cost" factor.

Losses once again were the determining factors in the dynamics of acquisition for the Rand model,

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<sup>43</sup>Bodilly, Pei, and Schank, Unit Cost Analysis, pp. 121-122.

<sup>44</sup>Bodilly, Pei, and Schank, p. 123.

<sup>45</sup>Ellen Balis and Deborah Clay-Mendez, Replacement Costs for Navy First-Term Personnel, by Rating (Alexandria, Va.: Center for Naval Analyses, 1982), pp. 3-8 passim.

<sup>46</sup>Non-rated officers are those in the Rand study that are not trained for flying duty.



which in this case referred to TAR personnel. The fact that most NRF billets afloat were filled by personnel with a prior first-enlistment affiliation had a substantial impact on the similarity between active and reserve costing within this category.

Rand researchers used a costing technique very similar to that which they employed for active duty recruitment and training, with one essential difference: all SELRES personnel with prior military service were excluded from these costs. The influence of this factor on total costs is substantial; Schank and associates observed that only 8.2 percent of enlisted and 17.5 percent of officers in the Selected Reserve had been inducted directly into reserve service. (By comparison, similar figures for active duty personnel were 100 percent for both categories.)

The Rand study group observed that when factored with losses, the "turnover rate" of SELRES enlisted personnel was approximately 1/7 that of active duty, while a similar officer ratio was approximately one-half. Because of their relative minority in both AD and NRF frigates, the resulting cost values for recruitment and training were much closer in the final calculations;

\$110,000 and \$80,000 per annum for each AD and NRF officer, respectively. Similar enlisted figures were \$960,000 and \$380,000 for AD and NRF ships.<sup>47</sup>

b. VAMOSC

This document included costs for 'C' and 'F' schools in the annual cost summary. It does not consider costs that occurred before the publication's fiscal year and is not cumulative in its effects upon the individual crewmember's training costs. As a result, the VAMOSC provides a clear 'snapshot' of fiscal year AD ship training costs, but little more.

c. Economic Analysis Report

This study breaks down the costs of accession and training as individual elements into a total cost and compensation matrix for rates and ratings of Navy personnel. The technique used for costing here--to spread out costs over the expected period of useful service--is similar to that employed by this thesis.

2. Thesis Costing Technique

All personnel onboard each command during FY 1986

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<sup>47</sup>Bodilly, Pei, and Schank, Unit Cost Analysis, pp. 119-123, 136, 137.

are costed for their preliminary recruitment and training in this sub-category.<sup>48</sup>

This approach to personnel costing is a significant departure from the methods employed by previous researchers, because it distributes the costs of acquisition and training evenly over the individual's enlistment period. The redistribution only makes sense. No study would attempt to say that the annual cost of ship's operations should include the expense of constructing and fitting out that ship; why then do this for the personnel that man her?

SELRES personnel are costed for the training appropriate to their rate and rating or rank and specialty. This places a significant additional cost upon the reserve account and eases the burden that other researchers place upon the active account. The redistribution is justifiable based upon the results of recent Navy policy. One variable that the Navy has had the opportunity to change in order to improve SELRES affiliation rates has been the length of the universal military training obligation. In changing the obligation from six to eight years in FY

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<sup>48</sup>A clear demarkation line exists for most personnel at the end of their initial military obligation. Junior officers typically receive post-graduate or specialty educations, while many AD enlisted personnel reenlist for Selective Reenlistment Bonuses and advanced training. These cases are considered in the next sub-category.

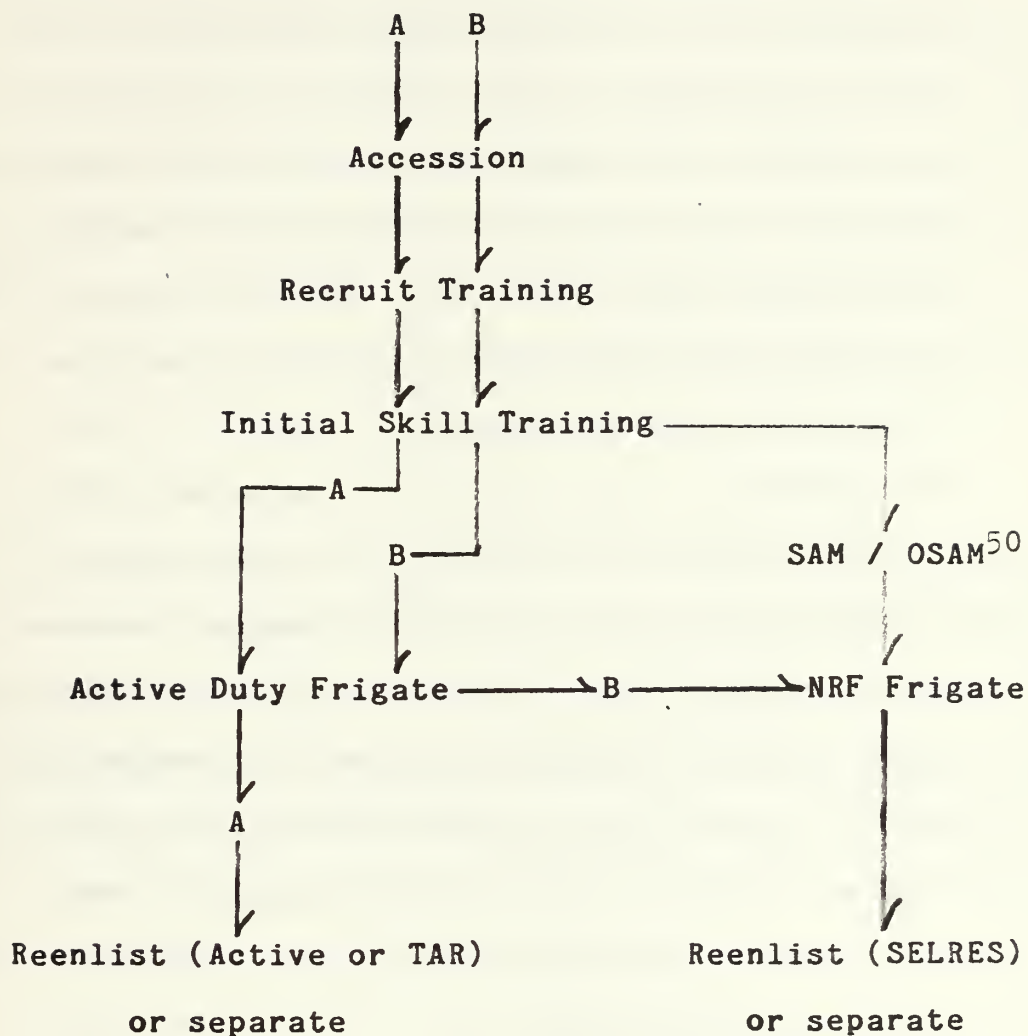
1985, a specific benefit was to take advantage of study results<sup>49</sup> that indicated that the likelihood of post-active duty affiliation in Navy ratings would increase with an additional service obligation, at no significant cost in active duty enlistments lost. This action inexorably linked the enlistee with both the active duty and reserve elements of the Navy, because the required span of active service would only be four to six years of this period.

Figure 2 reflects the change in first-term personnel flows that this policy has caused. Traditionally, the sailor that elected not to reenlist was discharged from active service with no constructive time remaining for required reserve affiliation (**Flow A**). With a longer obligatory service period, **Flow B** became a significant entity.

The model that this thesis uses is a dynamic one (much like Rand's) in that the actual unit strength, rather than the standard manning level, is the focal point in calculating costs. The limited survey size allows each unit to be examined at current manning levels, rather than exclusively for its losses in the manner that the Rand group does. These personnel can, in turn, be identified by their rate and rating or rank and sub-specialty.

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<sup>49</sup>Quester, Enlisted Accessions of Navy Veterans, p. 10.



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Figure 2: First-Term Personnel Assignment Paths

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<sup>50</sup>SAM/OSAM (Sea-Air-Mariner/Officer Sea-Air-Mariner) refers to new Naval Reserve induction programs instituted in 1984, that allow direct access for personnel into the Naval Reserve after completing basic training and initial schools. These programs had no influence upon this study, although they well might as the programs mature.



In dealing specifically with the initial military obligation of both officers and enlisted personnel, the solution here is to charge that fraction of initial recruitment and training costs to the unit (active or NRF) to which the sailor is affiliated. As an example, the billet that is filled onboard an NRF unit with a first-term enlistee whose average cost of recruitment and training is \$10,000 causes a charge of \$1250 ( $\$10,000 / 8$ ) to be levied upon the command in this costing sub-category.

The "current costs" of unit operation include those that induce the individual to affiliate with the command. Current pay and allowances, prospects for advancement, bonuses, and additional training are the tangible and intangible factors that become important here. The costs of initial screening and training are placed upon the individuals assigned to each command on an amortized basis consistent with the method previously described.

Officer accessions to surface ships require considerably more preparation for duty after initial military induction. A consideration in applying costs for junior officers begins by identifying the number associated with the surveyed ships that are still serving their period of initial military obligation.

Several considerations enter into the officer cost equation here:

a. "All officers are not created equal"

Costs of advertising and initial induction may be considered equal among officers, but the "pipeline" to the ship may vary widely in cost, depending upon the source of each undergraduate degree. Naval Academy graduates carry a substantially higher taxpayer pricetag than either ROTC or Officer Candidate School graduates.

b. Induction costs

Induction costs may be different for officers, depending upon their pipeline source date. Typically, Naval Academy and NROTC four-year scholarship induction costs are incurred in the fifth fiscal year prior to assignment to the ship. Recipients of ROTC two-year scholarships incur processing costs in the third fiscal year prior to ship assignment. OCS graduate processing may be done largely in the fiscal year immediately prior to commissioning.

The initial skill and specialty training for officers comes shortly after preliminary training at the Academy, OCS, or ROTC. For unrestricted line officers, the uniform path takes all entrants through the basic course at the Surface Warfare

Officer School and then into follow-on specialty courses in ASW, missile, navigation, or propulsion training. Junior supply officers attend the basic course at the Supply Officer's School before ship assignment.

Values for enlisted first-term personnel were drawn from the Enlisted Distribution and Verification Reports of individual commands. Officer values were taken from individual unit Officer Distribution Control Reports.

TABLE V  
NUMBER OF FIRST-TERM PERSONNEL

|                      | Enlisted | Officer |
|----------------------|----------|---------|
| FF-1052 Class (AD):  | 154      | 12      |
| FF-1052 Class (NRF): | 102      | 10      |
| FFG-7 Class (AD):    | 66       | 10      |
| FFG-7 Class (NRF):   | 74       | 5       |

The numbers cited above reflect sailors received between 1 October 1985 and 30 September 1986. Initial enlistment dates for these personnel are aggregated by fiscal year in Table VI.

First-term personnel were identified using the

ODCR, EDVR, and NRF Manning Matrices of each command. These individuals were then costed using the Economic Analysis Report, applying the values noted under matrix entries "accession" and "initial training". Results were summed and averaged by ship type and organization, as is noted below.

Selected Reservists were identified using individual Enlisted Unit Profile Reports (CHNAVRES-NRPC-1080-1363) and costed in a manner similar to that described for AD personnel.

TABLE VI  
SURVEY ENLISTED RECRUITMENT DISTRIBUTION

|                      | FY81 | FY82 | FY83 | FY84 | FY85 | FY86 |
|----------------------|------|------|------|------|------|------|
| FF-1052 Class (AD):  | 1    | 6    | 13   | 46   | 68   | 20   |
| FF-1052 Class (NRF): | 0    | 0    | 6    | 12   | 74   | 10   |
| FFG-7 Class (AD):    | 1    | 7    | 9    | 16   | 27   | 6    |
| FFG-7 Class (NRF):   | 2    | 4    | 8    | 14   | 24   | 22   |

## Unit Acquisition and Initial Training Costs<sup>51</sup>

FF-1052 (AD): \$650,206

FF-1052 (NRF): \$719,797

FFG-7 (AD): \$444,673

FFG-7 (NRF): \$515,769

### 3. Comparative Analysis

Because the techniques used by this thesis vary widely from other capable evaluations, the specific differences in analysis are worth explaining:

- a. The thesis explores unit manning levels, subject to current year fluctuations; others evaluate losses. Fundamental to the nature of this study is the cost of individuals actually assigned to the command. These are either the arrivals within the fiscal year or those that are incumbents; the reasons for their assignment are only of secondary importance to the fact that they are there. Measuring losses injects a dynamic influence into an otherwise static model, but it does not truly capture the essence of the accession costing problem by solely examining attritions.
- b. Cost analysis made by this thesis assumes that the costs of recruitment and initial training are recouped by the Navy over the course of the

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<sup>51</sup>Values have been transferred to the Unit Cost Summary on page 178.



enlistment, a fraction of which is FY 1986. Other studies use a "block purchase" technique that, in essence, attempts to cost all cumulative human investments made by the Navy to date. This approach has its merits--it does provide the reader with a notion of the investment made in human capital--but it is not a practice that is done on a consistent basis throughout the entire unit costing analysis. This study solely considers the costs that emerge within a specific ("annualized") block of time.

- c. This study applies the costs of accession and training to the current beneficiary, which is the AD unit, NRF unit, or the SELRES detachment. The Rand study elected to place the burden of initial training costs on the AD unit, as the prime beneficiary of the initial enlistment. What follows from this is that SELRES personnel bound for shipboard duty possess skills which should be available at an unskilled wage rate, because their previous training presumably carries no implicit value. Such a conclusion is hardly realistic.
- d. Both the Rand study and this thesis isolate costs in this category for averaging; the associated costs of PCS and TAD travel associated with

transportation after accession and training costed under the travel cost category.

Rand views that recruitment and initial training costs should be borne by the initial beneficiary of that training, which in nearly all cases, is the active duty unit. The legitimacy of this argument was strong (but not impervious) when the military obligation associated with the first enlistment was six years; by FY 1986 the obligatory service period for all accessions was eight years--the active enlistment considerably less--and the mandatory enrollment in a component of the Naval Reserve for first-term enlistees a matter of fact.

One question remains: why are NRF acquisition and training costs greater than those of their AD counterparts? The answer here appears to lie in the fact that a majority of personnel in each SELRES detachment are serving out the remainder of their UMO with the NRF. Using USS Duncan as an example, 49 personnel in the detachment were first-term personnel (from the detachment average strength of 65.6) of which 12 had joined the detachment during FY 1986.

Given that we find a higher proportion of first-term personnel serving in each ship's SELRES

detachment than in the full-time crew, we may then expect that costs associated with career acquisition and training for the SELRES will be proportionally less.

#### F. SELECTIVE REENLISTMENT BONUSES AND ADVANCED TRAINING

The previous section targeted costs associated with the recruitment and initial training of each ship's crew. A substantial fraction of any ship's crew is composed of individuals that chose to continue their military service and as a result, receive reenlistment compensation and additional training opportunities. In doing so, they execute a new enlistment contract (active enlisted) or sign a Ready Reserve agreement (TAR-SELRES enlisted and officers). Active duty officers have no explicit extended service agreement.

Regardless of the nature of the agreement that is made between the individual and the Navy, the relationship between both parties changes; the apprentice of the first obligatory period becomes the journeyman and later, the ship's specialist in the field. Costs and inducements that the Navy must compensate with follow suit; wages increase with additional years of service, additional professional qualifications, and the rank or rate associated with increased responsibilities.

The costs that this thesis will focus on in this section include selective reenlistment bonuses, and the costs of advanced professional and technical schools.

# 1. Current Studies Costing Techniques

## a. Rand Study Group

Schank and associates included the costs of SRBs and supplemental professional pays within the general category of "pay and allowances" previously discussed as having been derived from Justifications. The costs of advanced technical and professional schools were not dealt with in the Rand paper because of non-availability of 'C' school data.

An average value for TAR bonuses was developed from the total TAR bonus value provided in Justifications, divided by average TAR manning strength.<sup>52</sup>

In much the same way that TAR costs were obtained by this group, an average cost for SELRES bonuses was found by dividing total funds expended for reserve bonuses by the average total strength of the Selected Reserve for the year. Rand

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<sup>52</sup>Bodilly, Pei, and Schank, Unit Cost Analysis, pp. 117, 119.

researchers summed this cost at \$48 per SELRES enlisted, and nothing for SELRES officers.<sup>53</sup> This cost is likely to be understated, for two reasons:

(1) Advanced schools are not included in costs.

Some SELRES personnel selected for shipboard duty receive brief or modularized advanced training courses. The "average" reservist does not require supplementary training for Naval Reserve Center drills. As a result, the "average" cost value is likely to misrepresent actual advanced training costs.

(2) Bonuses are paid for skills possessed by ship systems technicians. Active service members received SRBs in FY 1986; TARs and SELRES personnel did not, but did receive modest affiliation bonuses in specific cases.

b. VAMOSC

The VAMOSC included the costs of SRBs within the enlisted data elements extracted from the Navy Finance Center. These costs were not isolated for evaluation. As has been noted previously, the costs of Regular Navy, TAR, and SELRES personnel assigned to the NRF units were not included.

The VAMOSC is further inhibited because it states that it only accounts for costs incurred during

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<sup>53</sup>Bodilly, Pei, and Schank, p. 117, 119.



the fiscal year by each unit then under evaluation. This means that advanced training expenses and SRBs awarded before FY 1986 were not considered; neither have SRBs or training that were expensed before their recipients arrived at one of the survey units, even if it was during FY 1986.

## 2. Thesis Costing Technique

This paper breaks step with the Rand model because of differences in costing philosophy. The Rand paper evaluated all service members joining the command as being within an acceptable range of a norm: the 'average' officer or enlisted person has been costed for pay, allowances, and supplementary benefits through Justifications costs and force personnel strengths.

Are shipboard personnel within an acceptable variance in behavior from the remainder of Navy personnel? Rand implies that they are, and given the size of the Rand survey, this indeed may be the case. There is no analysis however, that would confirm this expectation. This technique invites criticism for a model with the size presented in this thesis for all except the most difficult-to-cost elements.

In general, the characteristics that reflect the "average behavior" of the Navy do not necessarily

represent the behavior of the officers and men of these frigates. These characteristics may be evaluated more efficiently for a population of this thesis size by separately considering the following:

- a. Command reenlistments and new prior-service accessions.
- b. SRBs, by number, bonus eligibility zone, and rating.
- c. Command new accessions at the department head level (and above) for naval officers.

Using what should now be a familiar technique, this thesis incorporates specific personnel characteristics taken from unit ODCRs, EDVRs, and NRF Manning Matrices for FY 1986. The Economic Analysis Report was then used to identify annualized values for Selective Reenlistment Bonuses and advanced training, taking each of the individuals identified above and pricing them by their rate (or rank) and rating.

TAR and SELRES personnel do not receive SRBs; as a result, these crewmembers are costed only for advanced training consistent with their rate and rating.

Using the technique described above, this data represents summary values averaged for the ships in the survey, by ship type and organization:

## SRB and Advanced Training Costs<sup>54</sup>

FF-1052 (AD): \$362,541

FF-1052 (NRF): \$318,392

FFG-7 (AD): \$254,067

FFG-7 (NRF): \$251,862

### 3. Comparative Analysis

Cost analysis of the previous sub-category led to the expectation in this area that NRF units would be less expensive to man, because of fewer career personnel in the SELRES detachment. The indications here are that this may contribute in some minor regard to lower manning costs. Both classes of NRF ships do edge out their AD peers for cost savings in this category. Table VII provides a breakdown of these costs.

A significant factor in cost savings for this sub-category is that TAR and SELRES personnel were not eligible for the SRBs that their AD counterparts received and as a result, have not been costed here for them. This factor resulted in an average savings of \$35,278 for the NRF FF-1052s and \$16,848 for the NRF FFG-7 class ships.

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<sup>54</sup>Values have been transferred to the Unit Cost Summary on page 178.

TABLE VII  
SRB AND ADVANCED TRAINING COSTS

|                           | AD      | NRF     | AD      | NRF     |
|---------------------------|---------|---------|---------|---------|
|                           | FFG-7   | FFG-7   | FF-1052 | FF-1052 |
| Active Personnel          | 201     | 138.7   | 262.5   | 186.6   |
| Associated Costs(\$)      | 254,067 | 183,558 | 362,541 | 212,521 |
| <u>Average Active(\$)</u> | 1264    | 1323    | 1381    | 1139    |
| SELRES Personnel          | --      | 62.8    | --      | 101.7   |
| Associated Costs(\$)      | --      | 68,304  | --      | 105,871 |
| <u>Average SELRES(\$)</u> | --      | 1088    | --      | 1041    |

Overall average costs for all four ship categories are buoyed up by the investment made by the Navy in SRBs and advanced training for critical, technical middle-grade ratings serving on active duty.

#### G. RETIREMENT COSTS

The cost of military retirement is an ongoing issue of debate and, as will be observed here, rightly so. As an element of deferred compensation, it is alternately viewed as an exorbitant drain on taxpayer resources and as an inducement for years of continued military service at less-than-competitive current wage rates for middle-grade managers and supervisors.

The military retirement system is "contributory"; the Navy, as well as the other armed services, is required to allot a portion of appropriated funds budgeted to the personnel account to establish and maintain an actuarially sound retirement fund for its personnel.

Key differences separate active and reserve retirement compensation plans. For both active officers and enlisted, the service member may retire (and draw compensation beginning at the twentieth anniversary of initial active duty). It is not uncommon then, to find ex-servicemen at their fortieth birthday, drawing a stipend equal to 50 percent of the monthly base pay that they were being paid at the time of their retirement. Additional retirement benefits gradually accrue to the active service member as years of service beyond the obligatory twenty are completed; for each additional year, the service member may currently see a 2.5 percent increase (beyond the 50 percent baseline), to a maximum of 75 percent of base pay receivable per annum for 30 years of completed active service. The benefits attributable to TAR personnel are similar to those available to their Regular Navy counterparts.

By contrast, the reserve retirement benefits are almost penury. Twenty years of "qualifying service" are required but, by in this case, any benefits derived are not payable until age 60. A certain degree of mental vigor is required to calculate the benefits to be derived from the reserve



(officer and enlisted) retirement scheme; a system of 'points' that may be earned for active duty, drill participation, reserve participation, and correspondence course completion comes into play. No minimum percentage of base pay (comparable to active duty's 50 percent) exists; a "reasonably accurate method is to credit 2.5 percent for each year of active duty and 0.5 percent for each year of satisfactory service on inactive duty."<sup>55</sup>

While calculating the value of the retirement accrual was a fairly simple process for actuaries involved in identifying the annual contribution, the complex system of "reserve points" (which demanded continuous, scrupulous book-keeping on the unit level) has taken several years to refine. This point was particularly important as DoD tried to develop an effective dual accrual system.

#### 1. Current Studies Costing Techniques

The Department of Defense (DoD) Office of the Actuary evaluates current and future manning in the light of projected economic considerations to derive the present value of the retirement investment that must be made. This investment, the Normal Cost Percentage (NCP), is displayed as a percentage of the current payroll for force-wide base pay.<sup>56</sup>

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<sup>55</sup>Commander, Navy Recruiting Command, Naval Reserve Career Information Guide for Enlisted and Officer Personnel, (1986), p. 16.

<sup>56</sup>Bodilly, Pei, and Schank, Unit Cost Analysis, p. 13.

a. Rand Study Group

Schank and associates analyzed the current method of service contributions and highlighted the risks in retirement costing. They observed that to use a "force-wide NCP" in the frigate costing problem would be saying that the benefits of retirement provided for active duty personnel throughout the military establishment have the same value as that provided for reservists. As has already been proposed however, this is not the case; the value of active duty retirement compensation is substantially higher and available to the service member much sooner.

The single actuarial value in vogue for FY 1985 was 50.7 percent of individual base pay. The Rand group has used alternate unpublished DoD actuarial sources to provide a "dual accrual percentage" that isolated the contribution made by the Navy for the two personnel categories. Predictably, the revised NCP that applied to reserve retirement benefits at 8.1 percent, was substantially less than the standard. The active NCP showed a slight increase at 52.2 percent.<sup>57</sup>

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<sup>57</sup>Bodilly, Pei, and Schank, p. 13.

b. Feldman Study

Using projections made into FY 1986 by OP-01, Feldman calculated separate costs for active, TAR, and SELRES personnel. In this case, retirement costs were 52 percent of base pay for active duty officers and enlisted, 26.9 and 26.0 percent of base pay and allowances for TAR officers and enlisted (respectively), and 7.8 and 7.7 percent of base pay and allowances for SELRES officers and enlisted.<sup>58</sup>

2. Thesis Costing Technique

Researchers have used the actuarial standard computation as the common method of identifying the current price of military retirement compensation. This thesis endorses the method, with the addition of the following considerations:

- a. Assume that the behavior of officers and sailors in this sample reflects the propensity of all U. S. military personnel (as a group) toward continued service and eventual retirement.
- b. Recognize that using the single value accrual percentage (as mandated by law prior to FY 1987) badly overstated the costs of reserve retirement, while slightly understating that for active and TAR personnel. The Office of the Actuary shifted

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<sup>58</sup>Feldman, Personnel Costs, p. 9.

to dual actuarial values in FY 1987; the dual values were authorized for use by Congress in October 1986, and reflected the growing confidence of DoD managers in both Active and Reserve record-keeping.

- c. In developing an accurate dual actuarial system, insufficient reserve data was available to provide a single figure that could be used with confidence prior to FY 1987. The best information available to both Rand and CNA researchers placed the NCP of reserve members at approximately 8 percent. This was viewed officially as fluctuating as wildly as a value between 2.8 and 42.9 percent for FY 1986.<sup>59</sup>

For the purpose of this thesis, a good guess based upon cumulative data is far better than a "fair" guess of the period. Rather than using the estimated single actuarial value of 50.7 percent for FY 1986, this thesis uses the approved dual values for FY 1987. Interestingly, the full-time accrual component at 52.2 percent is only slightly higher than its predecessors. This category includes the portion of the crew that are Regular Navy and TAR personnel. The

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<sup>59</sup>U.S., Congress, House, Subcommittee of the Committee on Appropriations, Military Manpower and Compensation Programs, pp. 819-821 and Military Retired Pay Accrual, 99th Cong., 1st sess., 1986, pp. 72-74.

part-time accrual component is 26.6 percent--midway between the extremes presented to Congress, but far above earlier expectations.<sup>60</sup> These values are then multiplied by the cumulative base pay of each component of the ship's crew for the year.

(Full-time Base Pay x 0.522)

+

(SELRES Base Pay x 0.266)

=

Retirement Cost per Unit

Normal Cost Percentage:

| <u>FULL-TIME</u> | <u>PART-TIME</u> | <u>COMPOSITE</u> |
|------------------|------------------|------------------|
| 52.2             | 26.6             | 50.7             |

Data management systems throughout the Navy routinely sum all pay and allowances as part of their accounting systems. As a result, finding an isolated value of the base pay for individual ships was impossible. The procedure used in this thesis to calculate base pay was to sum the number of personnel actually assigned to each command by rank/rate and rating during the year. (This information was

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<sup>60</sup>Telephone interview with the Chief Actuary, Office of the Actuary, Washington, D.C., 12 January 1987.



available in the EDVRs, ODCRs, and NRF Manning Matrices of each ship.) These individual values were then multiplied by the base pay values (also categorized by rate and rating) found in the Economic Analysis Report. The resulting figures were then summed and corrected to FY 1986 dollars.

#### Retirement Accrual<sup>61</sup>

|                |             |
|----------------|-------------|
| FF-1052 (AD):  | \$1,646,478 |
| FF-1052 (NRF): | \$1,457,353 |
| FFG-7 (AD):    | \$1,379,870 |
| FFG-7 (NRF):   | \$1,134,317 |

### 3. Comparative Analysis

The principal studies previously conducted in this category use the same technique as is presented here, with few modifications. The Rand study group uses FY 1985 values of 50.7 percent for the single DoD NCP and then carries the work through again using values of 52.2 and 8.1 percent for active and reserve force NCPs. With some elaboration, Feldman's corresponding values in FY 1986 were 50.7, 52.0, and 8.2 percent respectively.<sup>62</sup>

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<sup>61</sup>Values have been transferred to the Unit Summary Cost equation on page 178.

<sup>62</sup>Bodilly, Pei, and Schank, Unit Cost Analysis, pp. 37-38.

The only substantial differences between these three analyses are the NCP values available to researchers at the time of their writing, and the scope of their study. Both Rand and CNA used force average base pays, while this work uses the pay figures that correspond to the units in the survey.

### III. UNIT EQUIPMENT AND MAINTENANCE COSTS

The second major costing family that this thesis investigates is that of equipment, maintenance, and support expenses. Each ship is subjected to the same problems that face any complex machine in a hostile environment; labor and parts are required to repair specific equipments that fail with use or misuse, while labor and consumable articles are required to maintain the ship in a manner that is clean internally and well-preserved externally. All expenses within this family are recurring, although changes in management policy and equipment modifications may cause transient surges. All costs tend to be fixed with some small circumstantial variance. This is a result that comes largely from uniform maintenance practices and everyday management decisions.

Costing within this family falls into three separate categories, Equipment and Stores, Maintenance Support, and Base Operating Costs. Each of these will now be summarized, and their individual components will be studied in the remainder of this chapter.

Within the category of Equipment and Stores are a number of sub-categories that relate specifically to the costs that

arise from the purchase of consumables, parts, and equipments by ship's force on a recurring basis:

1. Organizational and Maintenance (O & M) Supplies;
2. Repair Parts; and,
3. Equipage.

Maintenance Support can come from any number of activities indigenous to the Navy: destroyer tenders and repair ships, Mobile Technical Units (MOTUs), Shore Intermediate Maintenance Activities (SIMAs), private or public shipyards, systems commands, and their affiliates. Each of these has technical expertise and maintenance facilities that exceed those of the ship itself. The ship then, has a very necessary dependence upon these organizations for continued material readiness.

This category includes all costs associated with the outside maintenance and unit support that has been briefly introduced here. While the costs of consumables and parts used for ship's maintenance by the crew are included in the previous family, the costs of labor, raw materials, and parts provided by the assisting activities are included here. This sub-category is identified as Intermediate- and Higher-Level Maintenance.

Included in Base Operating Costs are those outlays made by naval bases and subsidiary organizations, which help to support the crews and dependents of the survey ships.

## A. ORGANIZATIONAL AND MAINTENANCE (O & M) SUPPLIES

Shipboard maintenance often involves the use of consumable items for periodic equipment maintenance. Cotton swabs, O-rings, gaskets, and lint-free rags are among the many items that fall into this category; they are a part of a long list of low unit cost items that are hereafter referred to as maintenance supplies.

Organizational supplies include "the soap, toiletries, janitorial supplies, paper, and administrative items used by the unit"<sup>63</sup> in the course of everyday routine for ship's cleanliness, habitability, and management. Much like maintenance supplies, the unit price for organizational items tends to be low. In both supply sub-categories, the annual cost has a strong fixed element for both active and reserve ships.

### 1. Current Studies Costing Techniques

#### a. Rand Study Group

Rand characterized maintenance supplies as being consumable items used during equipment maintenance at either the organizational or intermediate levels.<sup>64</sup> The study noted that these are used principally for preventive or corrective

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<sup>63</sup>Bodilly, Pei, and Schank, p. 129.

<sup>64</sup>Bodilly, Pei, and Schank, p. 15.



maintenance, and that the costs vary with the "full-time personnel (manning) equivalent".<sup>65</sup>

In deriving a factor that could express the behavior of supplies costing, the Rand group observed "that as the number of full-time people on board the ship increases the use of (these) supplies increases".<sup>66</sup> Several assumptions about the organization then follow:

- (1) The cost of organizational supplies per full-time person is fixed, regardless of whether the unit is reserve or active;
- (2) The "number of full-time equivalent people on the ship can be estimated by allotting each person the number of days worked in a year and totaling the working days of the entire crew."<sup>67</sup> Reservists work 14 days (ACDUTRA) and (in Rand's calculations) 39 inactive drill days onboard the ship. What results is the "full-time manning equivalent" calculation for each unit, shown in Figure 3:

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<sup>65</sup>Bodilly, Pei, and Schank, p. 125.

<sup>66</sup>Bodilly, Pei, and Schank, p. 129.

<sup>67</sup>Bodilly, Pei, and Schank, p. 129.

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Manning (Officer and Enlisted)

x

Percent of Year Worked Onboard\*

=

FTME

\*(100 percent for active duty and TAR, 3.8 percent for SELRES)

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Figure 3: Full-Time Manning Equivalent Calculation  
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The Rand group then took the cost of supplies from VAMOSC, divided by authorized active duty manning strength and derived an average full-time cost value. This, in turn, was multiplied by the number of FTMEs to generate the O & M supply costs of each ship.

b. VAMOSC

The VAMOSC document summarized costs in this sub-category under the heading of "Consumables" (element 1.2.3.2) and included ship's force material costs during overhaul and those supplies that are "administrative and housekeeping, medical

and dental supplies, routine maintenance tools, . . . and general purpose hardware".<sup>68</sup> As an accounting tool, VAMOSC provides a comprehensive summary of costs within this sub-category.

The data required for this category are available from VAMOSC and appears to offer a high degree of accuracy. Individual units report the vast majority of their consumable purchases made in support of the Planned Maintenance System (PMS) through predictable Navy supply channels, which are, in turn, compiled by unit and forwarded to the Navy Cost Information System/Operations Subsystem (NCIS/OPS). The VAMOSC taps this information source for its data. While the Rand study and the NPFM may offer future cost prediction value, they cannot offer the historical accuracy available here for AD ships.

c. Navy Program Factors Manual

Costs within this category were summarized under "Other Ships OMN", which includes ship's consumables and equipage, but does not include any items used for equipment repair.<sup>69</sup> As a result, the predictive value of this document is limited

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<sup>68</sup>Commander, Naval Sea Systems Command (NAVSEA 017E2), VAMOSC, p. A-20.

<sup>69</sup>Office of the Chief of Naval Operations, Navy Program Factors Manual, p. 6.

in referring to this sub-category. The NPFM is further inhibited by the absence of NRF costing data, or explanatory information that would assist in updating the stated values.

## 2. Thesis Costing Technique

In budgeting for the purchase of consumable items onboard both active duty and NRF ships, the unit's financial managers are provided with a dollar figure by the Type Commander that represents the funds available to the ship on a quarterly basis. This Operating Target (OPTAR) fund is typically divided among the ship's departments based upon recent experience and expected need.

Included in the OPTAR are categories for repair parts and "other" items. (The latter category incorporates those items which is referred to here as O & M supplies.) These two categories are then broken down into several elements; the "basic OPTAR" (which is authorized quarterly by the Type Commander), authorized OPTAR augments (which are Type Commander supplements that must be justified by the command), loans from the Type Commander for short-term commitments, and Automatic Take-Ups (which fund overseas charters and hires, tug rentals, and telephone services overseas).

As the quarter progresses and supplies are required, the crew generates the appropriate documentation to make purchases from Navy supply stocks and, in limited instances, through direct purchases from civilian sources. In all cases, the expenditures are recorded as debits against the ship's OPTAR. The OPTAR roughly divides these expenses into the two general sub-categories that this thesis entitles O & M Supplies and Repair Parts. The key to accurately identifying the annual costs for these sub-categories is to then follow the accounting trail of recorded expenses to the points where Pacific Fleet ships' OPTARs are aggregated.

This thesis uses the information available from two such aggregation points in developing supply costs. The first is the funding source itself; the annualized values of disbursements for each unit were made available by the Fiscal Officer, COMNAVSURFPAC. The second information source was the Fleet Accounting and Disbursing Center Pacific (FAADCPAC), an organization which lies in the feedback loop between the ship's purchase and force recognition of that purchase. Once again, annualized values were available through this office.

As a result, this thesis has an extremely accurate picture of authorized funding and actual



disbursements that covers the breadth of the sub-category. One additional benefit exists: fluctuations between the authorized and actual expenditures are recognized here. The OPTAR is not a static accounting standard; as ship's operations change and needs or emergencies arise, the funding system must be flexible enough to allow sometimes substantial variances in funding. As one example, in Fiscal Year 1986 USS Duncan was budgeted for \$228,000 in this sub-category. Needs surpassed initial expectations however, and an additional \$98,400 were reprogrammed for use through Type Commander augmentations and transfers between funds then available for ship's use.

The significance here is that the 'bottom-line' for O & M purchases fluctuate with the needs of the individual ship. This costing technique captures these fluctuations and ensures their completeness and proper categorization.

Data for the costing sub-category that includes low unit cost items for routine maintenance, management, and habitability were taken from data sheets prepared by the Fiscal Officer, COMNAVSURFPAC and the Fleet Accounting and Disbursing Center Pacific (Code AFO-1):

## Unit O & M Costs<sup>70</sup>

|            |           |            |           |
|------------|-----------|------------|-----------|
| Wadsworth: | \$242,000 | Gray:      | \$416,000 |
| Duncan:    | \$326,400 | Lang:      | \$330,300 |
| Crommelin: | \$254,400 | Meyerkord: | \$262,600 |
| Jarrett:   | \$253,900 | Reasoner:  | \$390,600 |

### 3. Comparative Analysis

The VAMOSC has been referred to repeatedly in the course of this thesis. Its strength has been its accuracy and comprehensiveness in dealing with specific costing subcategories. Its weaknesses here have included that it does not state NRF costs of any kind, has no predictive ability, and provides no evidence that all of the OPTAR alterations referred to earlier have been included. Fortunately, VAMOSC does highlight the sources of its information and NRF supply procedures mirror that of the active force. Recorded expenditures may be available in this category through NCIS/OPS.

As a sidenote, the issue of the full-time manning equivalent in unit supply costing here should be addressed. As a forecasting tool the FTME may have some value, but as an accounting element it suffers from several maladies:

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<sup>70</sup>Values have been averaged and transferred to the Unit Cost Summary on page 178.

- a. Soap, toiletries, and the majority of other items required for the personal needs of officers and sailors are available from the ship, but require private purchase from the ship's store. No subsidy is provided to the crew for these items. As a result, they play no part in the actual outlay of funds for the ship's operation.
- b. The bulk of the janitorial supplies, paper, and administrative items required for ship's operation are required in much the same quantities for all ships of the same class--provided that the ship is manned at all--regardless of whether the ship is in active service or the NRF. Ship's housekeeping continues in all compartments; the dispensation of paper as reports, Plans-of-the-Day, and congressional responses carries on, regardless of whether 60 or 100 percent of the crew is onboard.
- c. The FTME fails to include the depot-level personnel that play an integral part in reserve ship organizational maintenance. They, like their crew counterparts, work on or near the ship. Do they then induce costs upon the ship in this area? The answer must be 'yes', but the degree to which this substantial work force creates additional costs is not considered by the FTME valuation.

d. The FTME is theoretically unwieldy because it implies that in one FTME a sailor is continuously active, onboard, and awake. For example, it suggests that because the average reservist dines once onboard the ship per four-hour drill period, his full-time counterpart then eats six times (at ship's expense) per 24-hour day.

The FTME is not valueless, however it has its flaws as a potential costing tool in this model.

#### B. REPAIR PARTS

Items required for the repair of the ship's equipment are categorized here as repair parts. The Rand study group, NPFM, and VAMOSC recognize the broad nature of this fixed and variable cost sub-category. The ship orders, retains, and expends repair items on its own behalf. Additionally, repair facilities independent of the ship may provide labor and parts for the repair of the ship. The cost of parts drawn from ship's stores and expended by ship's company are included here; parts and labor provided externally are costed in depot and higher maintenance sub-categories.

Naval units have a continuing need for funds to purchase or replace equipage, which are items that display high unit cost and vulnerability to pilferage. Binoculars, foul

weather jackets, electronic test equipment, and hand-held calculators are examples of equipage. The nature of the cost is fixed-variable; a small annual stipend is provided to each ship, unless the crew can provide reasonable justification for additional funding.<sup>71</sup>

The concept of unit budgeting through the use of the OPTAR was introduced in the previous section. Its importance as a planning tool and accounting standard is reiterated here; the OPTAR is fundamental to the ship's purchasing system and the costing methodology that this thesis uses.

### 1. Current Studies Costing Techniques

#### a. Rand Study Group

The Rand group differentiated between repair parts and O & M supplies. "This category includes the more costly subsystem components that must be replaced because of wear or condemnation."<sup>72</sup> The Rand group also observed that while sub-category costs are "generally variable, depending on only the equipment-operating levels",<sup>73</sup> the costs for the average

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<sup>71</sup>Commander, Naval Sea Systems Command (NAVSEA 017E2), VAMOSC, p. A-19.

<sup>72</sup>Bodilly, Pei, and Schank, Unit Cost Analysis, p. 15.

<sup>73</sup>Bodilly, Pei, and Schank, p. 15.



frigate tended to be fixed over the unit's cycle from one major shipyard availability to the next.<sup>74</sup>

To capture the costs for one year, Rand drew data from VAMOSC in FY 1983 that, under the broad heading of "Repair Parts" summed VAMOSC categories for repair parts, parts exchanges, and organizational issues.<sup>75</sup> The Rand study does not specify how the reserve unit's spare parts were costed in the model. A uniform costing equation is included in Appendix C, where repair parts equal the repair parts cost per ship,<sup>76</sup> but there is no explanation of where cost values came from, or the significance of fixed and variable portions of the cost. Because repair costs of active duty and reserve ships are equal in the summary cost equation,<sup>77</sup> the author assumes that this is viewed as a fixed cost (and thereby equal) or that the activities that both NRF and active duty ships were involved in resulted in variable costs that happened to be equal.

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<sup>74</sup>Bodilly, Pei, and Schank, p. 125.

<sup>75</sup>Bodilly, Pei, and Schank, p. 130.

<sup>76</sup>Bodilly, Pei, and Schank, p. 136.

<sup>77</sup>Bodilly, Pei, and Schank, p. 137.

Neither case is entirely plausible.

The Rand study group does not explicitly include equipage as a cost element in their equation. Because its costing behavior is consistent and small in comparison with that of the repair parts account, it is assumed that the equipage account has been absorbed into the larger category.

b. VAMOSC

By FY 1985, the data point which summarized the cost of repair parts used for the alteration and repair of the ship was "Repair Parts" (element 1.2.2), which detailed those parts purchased by the ship to repair its own equipment or to replace onboard spares expended. VAMOSC does not identify NRF costs, but does identify the data sources for its elements, which may record expenditures made by NRF units.

VAMOSC report equipage as "Equipment/Equipage" (data element 1.2.3.1). The data for this element originated with NCIS/OPS, which reported all Navy Stock Account items not included as either consumables or repair parts.

### c. Navy Program Factors Manual

The NPFM provided a class costing value for repair parts that is applicable to FFG-7 and FF-1052 class ships in active service. Costs associated with repair parts for Naval Reserve Force ships are not tabulated by the NPFM. Values available have highly questionable worth both because the factor values represent class averages, and because of cumulative changes in ships operations and repair parts purchasing behavior since the last revision to the NPFM in 1980.

## 2. Thesis Costing Technique

This thesis draws its data from information and annual cost figures provided by COMNAVSURFPAC and FAADCPAC. The earlier section in this thesis which highlighted consumable O & M supplies illustrated the use of the OPTAR as a precise measure of annual expenditures. By the same method, this thesis reports expenditures associated with repair parts consumed during the year by each of the units in the survey. Equipage expenditures have already been aggregated into the data values provided by both COMNAVSURFPAC and FAADCPAC.

Data for the repair parts sub-category have been taken from data sheets provided by the Fiscal Officer, COMNAVSURFPAC, and by Code AFO-1, FAADCPAC. In this instance, the COMNAVSURFPAC data provided an extensive breakdown of repair parts costs, while the FAADCPAC data was useful to corroborate the first source's findings. The data reflects annualized expenditures made by the eight ships in the survey for repair parts and equipage during Fiscal Year 1986.

#### Unit Repair Costs<sup>78</sup>

|            |             |            |           |
|------------|-------------|------------|-----------|
| Wadsworth: | \$820,000   | Gray:      | \$477,300 |
| Duncan:    | \$1,272,400 | Lang:      | \$383,000 |
| Crommelin: | \$966,200   | Meyerkord: | \$672,200 |
| Jarrett:   | \$970,900   | Reasoner:  | \$804,600 |

### 3. Comparative Analysis

The Rand study group considered this costing sub-category to be recurring and variable in the short-term, while being fixed over the course of the ship's repair cycle. As a force-wide evaluation, this concept appears accurate. The NPFM applied a fixed value for all unit costs over time, thereby taking an opposite stance in analysis; it presumes that there

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<sup>78</sup>Values have been averaged and transferred to the Unit Cost Summary on page 178.

are no fluctuations throughout the ship's operating cycle--a notion that the author has personally found to be unreliable. The position presented in this thesis is that the nature of repair parts costs is fixed, with a substantial variable element.

Equipment failure occurs through use, misuse, or no use at all. Normal wear-and-tear causes predictable equipment failure; using equipment improperly or beyond stated specifications leads to early parts failure. Paradoxically, electronic and pneumatic systems tend to fail more often when seldom used.

The Planned Maintenance System (PMS) is an institutional program designed to identify and prevent equipment failure through optimum use, effective maintenance, and early diagnosis of failures. This system induces much of the fixed nature in repair parts costs, because of systematic operation and tests of ship's equipment. Predictably, the cost of a repair part does not occur until someone activates the equipment and notices that it does not operate correctly. The PMS system causes these tests to occur regularly, with the flexibility to identify tests that must be done at sea or inport. Small by comparison with the other costs of supply and maintenance, equiptage is not singled out by other researchers as a separate costing sub-category. This



is an interesting division nevertheless, because its behavior has a fixed foundation with a variable, circumstantial superstructure. Because individual purchases that comprise this have high unit prices, are relatively durable, and highly pilferable, higher expenditures in this sub-category may reflect the extremes in managerial behavior. Command management that recognizes an early need for new equipage and argues successfully for its funding is one extreme; lax equipage control procedures and high pilferage rests at the other extreme.

A strong variable element persists in repair parts costing, which is directly related to the operating tempo of the unit.<sup>79</sup> While significant, the behavior of this cost is not so marked or consistent to warrant including "repair parts" in the unit operating costs family.

#### C. INTERMEDIATE- AND HIGHER-LEVEL MAINTENANCE

A ship periodically requires assistance from organizations outside of itself to remain operationally ready. The nature of this assistance may follow many forms, which are listed here from those that are most, to least, intensive:

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<sup>79</sup>Bodilly, Pei, and Schank, p. 129.

## 1. Regular Overhaul (ROH)

An operational condition in which the ship is totally immobilized for widespread repair and upgrading. Lasting from six to twelve months, the ship typically undergoes drydocking (for hull and sonar repairs), and cyclic system upgrading (ship alterations and equipment modifications).

The conduct of the overhaul remains the responsibility of the Commanding Officer of the ship, but the majority of the work is actually accomplished by civilian or military technicians that have no organic association with the ship. Ship's force personnel are typically involved with work projects not contracted for in the shipyard work package, with shipboard habitation improvement projects, and with tests requiring ship's force verification and approval.

The regular overhaul is currently scheduled for active duty FF-1052 class frigates every six years. Reserve FF-1052 class frigates are not scheduled for overhauls, but instead undergo comprehensive Phased Maintenance Availabilities (PMA), which will be discussed in the next section. All FFG-7 class frigates participate in an "extended cycle for ship

modernization"<sup>80</sup> that provides for extensive equipment and ordnance upgrading on a scope similar to that of the ROH. Both AD and NRF FFG-7s are scheduled for the ship modernization periods at their tenth and twentieth years of service.

## 2. Selected Restricted and Phased Maintenance Availabilities

At substantially less time, expense, and outside manpower requirements than the regular overhaul, the family of 'availabilities' is designed to repair, upgrade, and restore the frigates periodically between their overhauls or modernizations. FF-1052 class frigates undergo Selected Restricted Availabilities (SRA), lasting from two to four months; NRF FF-1052 class and all FFG-7 class frigates undergo PMAs lasting three to four months. Figure 4 illustrates the interrelationship between overhauls, modernizations, and major availabilities for these three ship maintenance classes:

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<sup>80</sup> Office of the Chief of Naval Operations. Navy Training Plan, Naval Reserve Force Guided Missile Frigate (FFG-7 Class), S-30-7409E, (1984), Annex A-1, p. I-16.

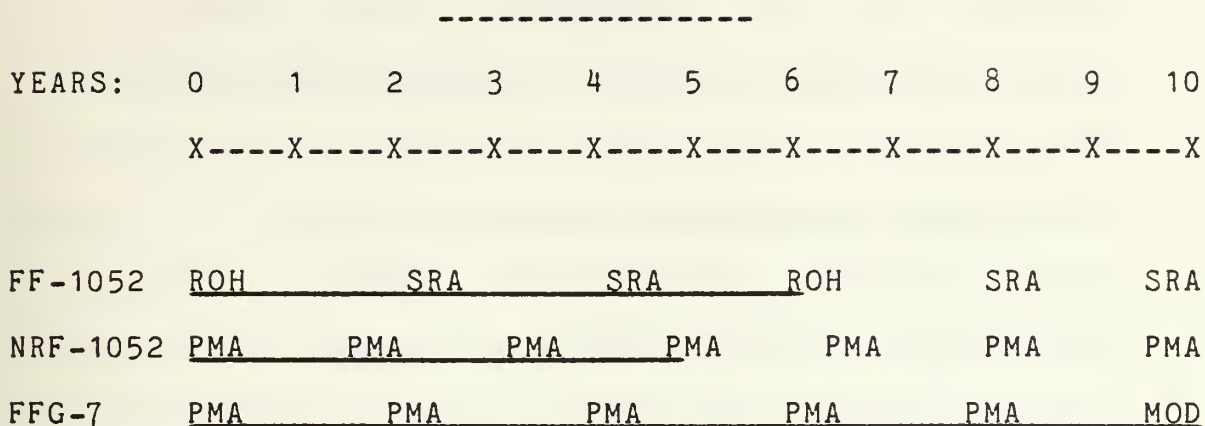


Figure 4: USN and NRF Frigate Maintenance Cycles<sup>81</sup>

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In both cases, the work conducted on each ship follows a uniform maintenance program that makes similar, periodic repairs, tests, and upgrades as each ship comes due for its availability. Emergent equipment and structural repairs are also undertaken. The ship is largely immobilized at a naval or private shipyard for this work, while the crew follows much the same routine as for a regular overhaul.

Most of the costs associated with regular ship operations are deferred while units are undergoing overhaul and the availabilities referred to thusfar.

POL is off-loaded before the ship enters the

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<sup>81</sup>See Commander, Naval Sea Systems Command (NAVSEA 05L14), Training Plan for the NRF FF-1052 Class Frigate, (1985), pp. I 9-11; Office of the Chief of Naval Operations, Navy Training Plan, FFG-7, pp. I-14, I-16; and "Ship Maintenance Policies, Naval message DTG 161409Z April 1985." (Teleprinted.)

shipyard, and all subsequent services provided are line items identified in the maintenance contract. The resultant costs then become part of the ship's higher-level maintenance account.

During FY 1986, USS Crommelin, Jarrett, and Gray participated in PMAs. Advanced funding was expended during the year to prepare for the PM and SR Availabilities of USS Wadsworth, Reasoner, Meyerkord, and Lang in FY 1987. The following tables highlight these maintenance actions and their costs.

TABLE VIII

NAVAL ORDNANCE STATION (LOUISVILLE) MAINTENANCE ACTIONS<sup>82</sup>

| <u>UNIT</u> | <u>ACTION (FY86)*</u>        | <u>COST</u> |
|-------------|------------------------------|-------------|
| Gray        | Overhauled MK 42/9 gun mount | \$639,000   |
| Reasoner    | Overhauled ASROC launcher    | \$740,000   |
| Duncan      | Overhauled MK 75 gun mount   | \$442,000   |

\* No NAVORDSTA expenses were incurred by the other five ships in this survey.

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<sup>82</sup>Telephone interview with Carl Turner, NAVORDSTA Louisville, Kentucky (Planning Department), 16 January 1987.



TABLE IX

COMNAVSURFPAC-FUNDED MAINTENANCE PROJECTS (FY 86)<sup>83</sup>

| UNIT      | EMERGENT FUNDS | OTHER FUNDS (REASON)             |
|-----------|----------------|----------------------------------|
| Crommelin | \$45,581       | \$1,421,645 (2.5 month PMA)      |
| Jarrett   | \$10,000       | \$1,571,570 (3.5 month PMA)      |
| Wadsworth | \$72,565       | \$48,000 (PMA advance planning)  |
| Duncan    | \$40,045       | ---                              |
| Reasoner  | \$58,410       | \$168,000 (SRA advance planning) |
| Meyerkord | \$68,921       | \$418,489 (SRA advance planning) |
| Gray      | \$242,092      | \$5,155,966 (3 month PMA)        |
| Lang      | \$52,191       | \$441,000 (PMA advance planning) |

The values listed above are for maintenance services provided to each ship using COMNAVSURFPAC funds. These costs do not include projects sponsored by systems commands, but do include funding for services provided by the Shore Intermediate Maintenance Activity (SIMA) in Long Beach and San Diego. Resources expended by Mobile Technical Unit Five (MOTU-5) are also reflected in these figures.

### 3. Technical Availabilities

The nature of the work in the two to four week Intermediate Maintenance Availability (IMAV) varies;

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<sup>83</sup>Telephone interview with LCDR Rocheleau, COMNAV-SURFPAC (Maintenance), San Diego, California, 4 February 1987.

ship's force plays the driving role here in identifying where work and repairs need to be accomplished in this category. Intermediate Maintenance facilities have maintenance capabilities, shop space, and technical expertise that exceeds those of the frigate, but somewhat less fewer resources than the major service organizations associated with the higher-level maintenance previously discussed. The IMA has the burden of responsibility to define the resources that it has available to accomplish the work that is within its technical capability. IMA facilities referred to in this thesis include the SIMA facilities in San Diego and Long Beach, the SIMA-Naval Reserve Maintenance Facility (SIMA-NRMF) in Long Beach, MOTU-5 in San Diego, and the destroyer tenders and repair ships assigned to the San Diego-Long Beach area.

The ship's machinery remains largely intact for technical availabilities, although this is an ideal period for "open-and-inspect" maintenance and limited pump, boiler, and systems work. The ship "stands down" from the routine state of operational readiness inport by some measure, and receives priority treatment from afloat and shore intermediate maintenance facilities.

The ship undergoing an IMAV remains pierside at the naval base, and incurs costs for services inport in much the same manner as it would for normal inport operations.

Scheduling arrangements for a technical availability varies somewhat between AD and NRF units. Active frigates participate in these availabilities every three to six months, while NRF units located in Long Beach continuously rotate through availabilities, subject to the SIMA-NRMF workload and each ship's operating schedule. Included in the costing for IMA work is the contribution to organizational maintenance referred to next.<sup>84</sup>

4. Intermediate level support for NRF units

A relatively new institution, IMA support for organizational-level work evolved from a need to man NRF ships with fewer full-time crew members while maintaining unit material readiness. The solution that evolved was to place a portion of the responsibility for ship's force work squarely in the hands of SIMA personnel. What this does, in effect, is to lower the organic costs of unit manning--because fewer, less qualified technicians are needed onboard --but costs are incurred nonetheless by making the

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<sup>84</sup>Telephone interview with LCDR Gary Shore, SIMA-NRMF (Repair Officer), Long Beach, California, 20 February 1987.

NRF units dependent upon maintenance expertise from a source remote to the ship.<sup>85</sup>

# 1. Current Studies Costing Techniques

## a. Rand Study Group

Rand observed that "ship repair, maintenance, and overhaul activities are usually fixed for a class of ships".<sup>86</sup> They added that "over a broad range of activity, the maintenance, repair, and overhaul needed is driven by corrosion control needs, rather than by operating tempo".<sup>87</sup> It was their view that both active duty and NRF units operated at sea sufficiently to make periodic maintenance for corrosion control necessary.

The Rand study group used predictions available from the Ship Maintenance Division of NOP-04 to estimate class average costs for IMA work. This was costed by NOP-04 in IMA man-years per year. Taking the figures provided by NOP-04, the Rand group used the cost of employing an E-6 for one year (\$15,374 in FY 1983 dollars), having observed that this rate represented the

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<sup>85</sup>Office of the Chief of Naval Operations, Report to Congress, 1985, pp. III 39-40.

<sup>86</sup>Bodilly, Pei, and Schank, Unit Cost Analysis, p. 129.

<sup>87</sup>Bodilly, Pei, and Schank, p. 129.

"average SIMA worker". Using estimates from the Atlantic and Pacific Fleets that stated that IMA workers were productive only 45 percent of the time, the Rand group divided productive labor-hours by .45 to derive required IMA man-years per year.

The Rand study group elected to use VAMOSC data averaged over a six year period that included all 46 ships in the FF-1052 class to derive overhaul and availability costs, which they then used in their cost equation. The same value was then applied to both the active duty and reserve ships. Because the Rand analysis studied the FF-1052 class exclusively, it did not consider the maintenance peculiarities of the FFG-7 class.<sup>88</sup>

The topic of additional SIMA human resources required for NRF organizational maintenance is one that is not explicitly treated by the Rand study, although it does deal directly with IMA manpower for both AD and NRF units where scheduled maintenance availabilities are discussed. The Rand study costed IMA human resources provided to both AD and NRF ships based upon a theoretical one-to-six ratio of

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<sup>88</sup>Bodilly, Pei, and Schank, pp. 131-132.



man-years necessary to support the AD ship in relation to its Reserve counterpart.<sup>89</sup> (Subsequent research by the Center for Naval Analyses noted below would indicate that the IMA maintenance support required is considerably less.) The Rand study thereby provided an inadvertent umbrella that covered most (if not all) of the costs that are associated with SIMA support for ship maintenance.

b. Frigate Maintenance Man-Hour Comparisons

This study by the Center for Naval Analyses (CNA) sought to verify the claim made by the Navy that "Reserve FF-1052 Class frigates require almost six times as many maintenance man-hours at the Shore Intermediate Maintenance Activity (SIMA) as Active Navy Frigates".<sup>90</sup> This analysis vocalized several interesting assumptions, which include the following:

- (1) "The unavailability of full-time crews on NRF ships to perform organizational maintenance shifts that burden to the SIMA."<sup>91</sup>

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<sup>89</sup>Bodilly, Pei, and Schank, p. 131.

<sup>90</sup>Asch, Beth and Feldman, Ronald. Frigate Maintenance Man-Hour Comparisons. Alexandria, Va.: Center for Naval Analyses, 1985. p. 1.

<sup>91</sup>Asch and Feldman, p. 1.

(2) AD and NRF units of the same class have similar organizational maintenance plans; and,

(3) The accomplishment of organizational maintenance is unrelated to the OPTEMPO of the ship.<sup>92</sup>

The study further implicitly assumed that work requests submitted by both AD and NRF units to the SIMA for accomplishment were all accepted, and that all organizational maintenance that required could be accomplished during scheduled IMAVs without causing the periodicity of the maintenance action to lapse beforehand.

The CNA study focused on maintenance data available from VAMOSC in FY 1983 that (interestingly enough) included both AD and NRF values for organizational and intermediate level maintenance. Their findings indicated that the maintenance labor required for NRF FF-1052 support was 1.5 to 3 times greater than that of its AD peer.<sup>93</sup>

c. VAMOSC

The VAMOSC management information system provided the information necessary to directly

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<sup>92</sup>Asch and Feldman, p. 1.

<sup>93</sup>Asch and Feldman, pp. 1, 4.

cost each unit for the fiscal year, having summarized costs imposed at the shipyard, subordinate IMAs, and affiliated systems commands. Regretably, this information system does not likewise aggregate costs for NRF units.<sup>94</sup>

d. Resource Requirements

This worksheet cites funding and resources required in the Reserve account to finance the growing number of NRF FFG-7s and FF-1052s between FY 1982 and FY 1988. Costs were isolated to within each of the maintenance categories listed above. One liability of this data source is that the worksheet does not discriminate between the two classes of ship or isolate estimated costs for individual units. The costs that can be derived here then are average ship values.<sup>95</sup>

2. Thesis Costing Technique

The costs that develop as a result of depot- and higher-level maintenance are widespread and, among the equipment costs discussed thus far, the one that

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<sup>94</sup>Commander, Naval Sea Systems Command, VAMOSC, Vol. 1, pp. A 39-41, A-53, A-65, A-76.

<sup>95</sup>Office of the Chief of Naval Operations (OP-39R), "Resource Requirements for 8 NRF FF-1052s and 16 NRF FFG-7s, FY82 - FY88," Washington, D.C., 1985. (Photocopied.)

is most difficult to isolate. A wide variety of organizations become involved in the material upkeep of Navy ships: central and local planning agencies must identify the work required to bring the ship to a robust state of readiness, while doing so within the budget allotted; a wide range of local maintenance facilities provide labor and raw materials to complete jobs as simple as making lifeline skirting to those as difficult as re-tubing main propulsion boilers. Systems commands nationwide take special interest in the condition, refurbishment, and replacement of their equipment. The pursuit of costs here must be comprehensive. There is the other side of the coin that must also be considered: it becomes counter-productive to include the unnecessary costs that are common elements included in overhaul management overhead.

Data sources for this sub-category have included the following:

- a. COMNAVSURFPAC Maintenance and Logistics Office;
- b. Naval Ordnance Station (Louisville) Planning Office;
- c. SIMA (San Diego) Supply and Comptroller Department;
- d. SIMA-NRMF (Long Beach) Executive and Repair Officers;

e. Long Beach Naval Shipyard (LBNSY), Analysis and Programming Division; and,

f. VAMOSC-MIS (NAVSEA 017E2).

The costs associated with ships' intermediate- and higher-level maintenance include the expenses incurred for direct labor and material consumed on behalf of the customer ship. Depreciation of maintenance facilities' assets, labor inefficiencies, wastage, and administrative costs above those directly associated with the ships in the survey have been discounted in this segmentation process as being part of higher-level maintenance overhead costs.

The summary cost of higher-level maintenance actions has been found by adding these expenditures:

a. NAVORDSTA Louisville Projects

Referred to in Table VIII.

b. COMNAVSURFPAC Funding

The values referred to in Table IX incorporate the costs of labor, material, and services provided to the survey ships in scheduled PMA/SRAs and for selected IMA services. Funds expended in preparing frigates for FY 1987 maintenance actions are included, as are extraordinary expenses resulting from material problems encountered during the year.



c. Systems command funding

Included in this category are expenses incurred by the Commander, Naval Sea Systems Command (COMNAVSEASYSCOM), LBNSY, and the Supervisor of Shipbuilding, Conversion and Repair (SUPSHIPS) for maintenance actions not specifically funded by the Type Commander. These costs are cited in Table X.

TABLE X  
SHIPYARD SYSTEMS MAINTENANCE COSTS<sup>96</sup>

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| UNIT    | EXPENSE (\$) |
|---------|--------------|
| Gray    | 589,000      |
| Jarrett | 906,812      |

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SIMA-NRMF manning resources have not been included above, and apply directly both as a result of technical availability work and organizational maintenance performed during the year. The following table lists the cost calculation and manhours provided by SIMA-NRMF to Long Beach-based units:

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<sup>96</sup>Telephone interview with Ethel Boykins, Long Beach Naval Shipyard (Budget Office), Long Beach, California, 6 March 1987.

TABLE XI

SIMA-NRMF LABOR COST CALCULATION (FY 86)<sup>97</sup>


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| UNIT:     | MAN-HOURS | x | STANDARD RATE* | = | TOTAL COST (\$) |
|-----------|-----------|---|----------------|---|-----------------|
| Wadsworth | 33,842    |   |                |   | 467,696         |
| Duncan    | 41,834    |   |                |   | 578,146         |
| Crommelin | 4,749     | x | \$13.82        |   | 65,631          |
| Jarrett   | 3,472     |   |                |   | 47,983          |
| Gray      | 26,293    |   |                |   | 363,369         |
| Lang      | 28,441    |   |                |   | 393,055         |

\* Hourly labor rate: \$13.82<sup>98</sup>

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The total cost of intermediate- and higher-level maintenance then becomes a summary of all the costs accumulated so far. These are, in FY 1986 dollars<sup>99</sup>

|            |           |            |           |
|------------|-----------|------------|-----------|
| Wadsworth: | 588,261   | Gray:      | 6,989,427 |
| Duncan:    | 1,060,191 | Lang:      | 886,246   |
| Crommelin: | 1,532,857 | Meyerkord: | 487,410   |
| Jarrett:   | 2,536,365 | Reasoner:  | 966,410   |

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<sup>97</sup>Telephone interview with LCDR Gary Shore, SIMA-NRMF (Repair Officer), Long Beach, California, 20 February 1987.

<sup>98</sup>Office of the Comptroller, Navy Comptroller Manual, 8 vols., (1986), Section 035750, p. V-96.

<sup>99</sup>Values have been averaged and transferred to the Unit Cost Summary on page 178.

### 3. Comparative Analysis

Costs that are used for calculation here are those reflecting only the units in the survey, and only for FY 1986. The rationale for this is two-fold; first, averaging intensive maintenance projects that occur in selected years of a ship's operating cycle may ensure that the full costs of higher-level assistance are included in some manner, but what the equation then demands is a corresponding average for all other operating values (over the course of the ship's cycle).

To explain this further, consider the fuel expenditures of a ship over the course of its operating cycle; with deployments and local exercises, fuel use will tend to be high (as will cumulative fuel costs). During overhauls there is no fuel use to speak of. The Rand group cites many of the costs observed by the Knox-class for one fiscal year, but deviates from this routine--and thereby violates cost-time uniformity--by considering six years of costs for higher-level maintenance.

This thesis attempts to crystallize the costs of the survey ships by unit, in a specific time period. To this end, only the costs of the eight ships are considered in this data base. What should become apparent to the reader is the extraordinary expense

associated with periodic ship maintenance by higher-level facilities; outlays for USS Jarrett (\$2.5 million) and USS Gray (\$7 million) accent this. The VAMOSC management information system provides the information necessary to directly cost each unit for the fiscal year, having summarized costs imposed at the shipyard, subordinate IMAs, and affiliated systems commands. Unfortunately, specific elements of the data base are unknown and values are only available for active duty ships.

The direct costs of SIMA-NRMF labor noted in Table XI reflect the added expenses associated with IMA support and (in the case of the NRF ships) organizational-level PMS accomplished by these personnel. The cost evaluation for these "fleet support" billets is not complete, however; personnel assigned to SIMA-NRMF expressly for the purpose of performing ship's PMS should themselves be costed in the same manner as the manpower assigned to the ships. To identify this requirement and to accomplish it are two different things. For one thing, the personnel that were to be assigned to the NRMFs expressly for the purpose of providing fleet support to NRF frigates does not agree as it goes from the planner's desk in Washington, D.C., to the SIMA shop floor. To clarify this point, the Navy stated in 1985

that "each NRMF is assigned 50 active billets (USN and/or TAR) to perform administrative and support functions, with an additional 100 billets for each NRF frigate assigned."<sup>100</sup> The actual billet structure for SIMA-NRMF fleet support billets falls far short of 100 men assigned per NRF frigate, and even more so when the combined duties of NRMF personnel are considered. As of FY 1986, a total of 48 active duty personnel with NEC qualifications were authorized for assignment to SIMA-NRMF Long Beach.<sup>101</sup> In practice, fleet support personnel are not isolated to duties on one ship or solely NRF ships, for that matter. SIMA personnel here perform in much the same manner as those assigned to active SIMAs, where priority service goes to the ship with a concurrent availability (either active or NRF) or with an outstanding casualty report (CASREP) that demands SIMA-NRMF expertise. NRF ships that require PMS support have third priority for service.

What then are the costs of the fleet support program? There are two ways to evaluate this:

- a. The Executive Officer and Repair Officer of SIMA-NRMF estimated that 40 percent of their

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<sup>100</sup>Office of the Chief of Naval Operations, Report to Congress, 1985, p. III-40.

<sup>101</sup>Chief of Naval Operations, Navy Training Plan (FFG 7 Class), Annex A-1, p. II-12.



organization's total workload was consumed by NRF organizational maintenance.

- b. An analytical assessment of the fleet support role shows something considerably less:

TABLE XII

SIMA-NRMF MAN-DAY EMPLOYMENT (FY 86)<sup>102</sup>

|  |        |
|--|--------|
| Man-days consumed for NRF IMA support:         | 29,813 |
| Man-days consumed for AD IMA support:          | 28,405 |
| Man-days consumed for NRF O-level maintenance: | 7,510* |

\* Includes survey frigates, plus USS Sides, Philips, and Racine.

Roughly assigning four-sevenths of the organizational-level maintenance figure to survey frigate support, 4291 man-days were then consumed by NRMF personnel. Assuming a five-day work week (with 10 national holidays) and in this case, discounting the "productive time factor" introduced by the Rand group, only 18 technicians were assigned to perform the supplementary PMS that these ships required.

The purpose of this thesis is to cost frigates, not SIMA-NRMF; the data and resultant observations above

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<sup>102</sup>Telephone interview with the Executive Officer, SIMA-NRMF, Long Beach, California, 17 February 1987.

are preliminary and cursory. Much more study is required in this area to accurately evaluate the support role of SIMA-NRMF.

#### D. BASE OPERATING COSTS

Naval bases exist to support the units that operate from them. Facilities are provided to berth and repair the ships while they are inport, to accomodate the sailors ashore, and to provide their dependents with decent living conditions, whether the ship is inport or at sea.

Costing this sub-category has its hazards. While the services provided throughout the naval station are tangible, only a fraction of these are relevant to the units within the scope of this analysis. Piers, buildings, and facilities constructed before FY 1986 are "sunk cost" and overhead assets which become irrelevant here. Operation of naval station administration facilities provides insufficient direct benefit to the units to warrant their inclusion, and also then become irrelevant. In short, costs that can be segmented sufficiently to illustrate a clear association with the ship, its crew, or their dependents become part of this sub-category.

##### 1. Current Studies Costing Techniques

###### a. Rand Study Group

The cost of Navy-wide base operations and real property maintenance was drawn from Justifications

using elements for real property maintenance, medical/dental services, and leased services. An average cost value for each authorized crewman was found, thereby providing the basis for a unit cost.

b. Navy Program Factors Manual

This document provides an early, class-wide average for active duty FF-1052 and FFG-7 ships. In conjunction with the Center for Naval Analyses, researchers based their costing evaluation on two key premises:

- (1) One-third of base operations personnel and operating funds were presumed to be affected by a marginal increase in the ship loading plan for the port. (That is, with the addition of one more ship to the base, one-third of overall base operating costs would vary directly, as a result.)
- (2) To actually estimate the contribution that each ship made toward the marginal increase in base variable expenses, the NPFM made the number of "non-support USN officers and enlisted" authorized for the ship a proxy for

the actual costs of base operations for which the ship was responsible.<sup>103</sup>

The NPFM does not estimate costs for the NRF frigates in the survey.

## 2. Thesis Costing Technique

To identify what the boundaries of this category are involves some controversy. At one extreme, it can be said that base operating costs should rightly belong in the Navy overhead account; the proof of this lies in the fact that base support facilities are very rarely augmented by a given incremental value (for either the individual sailor or ship) when the unit arrives in its new homeport. On the other hand, the ship and its crew has some dependence upon the naval base for subsistence and comfort, which must be provided at some cost.

This thesis isolates the specific costs that can be directly related to the support of the crew and their dependents and writes the balance of base maintenance and personnel support to the larger organizational unit that is the base. This interpretation is much stricter than that of either the Rand study or the NPFM, where total base operating costs are identified and then parcelled out, using the number of crewmen

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<sup>103</sup>Office of the Chief of Naval Operations, Navy Program Factors Manual, pp. 28, 32, 39, 40.

as a basis to establish the per capita cost. Those elements costed here (on a per capita basis) include:

a. Navy Family Housing, Operation and Maintenance.

This subset deals with Navy family housing and includes the costs of management, services, furnishings, maintenance, and utilities for the units available during FY 1986 to crew members of the survey units and their dependents. Table XIII provides an estimate of these costs.

TABLE XI

ESTIMATED MILITARY HOUSING COSTS<sup>104</sup>

| UNIT:     |                 | PERSONNEL HOUSED x AVERAGE COST* = TOTAL (\$) |        |          |
|-----------|-----------------|---|--------|----------|
| Wadsworth | 23              |   |        | 72,818   |
| Duncan    | 26              |   |        | 82,316   |
| Crommelin | 33              |   |        | 104,478  |
| Jarrett   | 30              | x   | \$3166 | = 94,980 |
| Gray      | 28              |   |        | 88,648   |
| Lang      | 50              |   |        | 158,300  |
| Meyerkord | 42 <sup>#</sup> |   |        | 132,972  |
| Reasoner  | 45 <sup>#</sup> |   |        | 142,470  |

\* Total O&M Budget (\$5.854K) / Total Number of Units (1849)

<sup>#</sup>Estimated

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<sup>104</sup>Telephone interview with Mr. Brady, Long Beach Naval Station (Housing Director), Long Beach, California, 19 January 1987.



## b. Commissary Operations

A benefit extended to all active duty and SELRES personnel while they are serving on ACDUTRA is the cost savings derived by making purchases from the Navy commissary store system. The cost of the operation of this store system is assisted by government subsidization, which should then be transmitted to the beneficiaries in the course of this analysis.

Finding the least common denominator within the Navy population proved to be particularly interesting in this case. Identifying the cost of regional and individual commissary operations was simply enough done, but what could this then be compared to for a per capita crew cost estimate? Commissary use varies from sailor to sailor, and the eligible population in the Los Angeles and San Diego areas (when active duty personnel, dependents, and retirees are included) is incalculable. In this instance, the author was forced to retreat from a ship-cost focus and accept Navy-wide population estimates.

The tabulation found in Figure 5 reflects the total operations and maintenance costs for the Navy commissary system:

|                            |                   |
|----------------------------|-------------------|
| -----                      |                   |
| Military Personnel Funds   | \$35,473,000      |
| Civilian Pay               | (+) \$56,936,000  |
| O & M - Nonpersonnel       | (+) \$25,254,000  |
| -----                      |                   |
| Total Operating Subsidy    | (=) \$117,663,000 |
| (Surcharge) <sup>105</sup> | (-) \$43,800,000  |
| -----                      |                   |
| Net Operating Subsidy      | \$73,863,000      |
| -----                      |                   |

Figure 5: Commissary Subsidy Calculation<sup>106</sup>

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<sup>105</sup>Patrons offset subsidy costs in some measure by paying a five percent surcharge on all commissary purchases.

<sup>106</sup>U.S., Congress, House, Subcommittee of the Committee on Appropriations, Military Commissary System, 99th Cong., 2nd sess., 1986, p. 479.

Figure 6 identifies the means by which commissary costs are calculated for each unit in the survey. The active duty crew computation is presented in Table XIV.

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$$\frac{\text{Commissary Subsidy (net of surcharge)}}{\text{divided by}} \frac{\text{Average Active Duty Strength (Officers and Enlisted)}^{107}}{\text{multiplied by}} \frac{\text{Average Full-Time Unit Manning}}{\text{plus}} \text{SELRES Commissary Benefits Estimation}$$

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Figure 6: Commissary Benefits Cost Methodology

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<sup>107</sup>Commander, Navy Military Personnel Command (NMPC-1654H), Third Quarter FY86, Navy Military Personnel Statistics, NAVPERS 15658, p. 7.

## TABLE XIV

## UNIT FULL-TIME MANNING COMMISSARY SUBSIDY

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$$\$73,863,000 / (587,682 \text{ PERSONNEL}) = \$125.69$$

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AVERAGE FULL-TIME MANNING (FY86)    x    SUBSIDY    =    TOTAL (\$)

|            |       |   |               |        |
|------------|-------|---|---------------|--------|
| Wadsworth: | 135.7 |   |               | 17,055 |
| Duncan:    | 141.7 |   |               | 17,810 |
| Crommelin: | 206   |   |               | 25,891 |
| Jarrett:   | 196   | x | \$125.69    = | 24,634 |
| Gray:      | 184.3 |   |               | 23,164 |
| Lang:      | 188.8 |   |               | 23,729 |
| Meyerkord: | 272   |   |               | 34,186 |
| Reasoner:  | 287   |   |               | 36,072 |

-----

Selected Reservists and their dependents are entitled to use commissary facilities while on active duty. Costing for this category is done by taking the per capita active duty cost derived above, dividing by that portion of the year that the SELRES detachment was eligible to use the commissaries, and then multiplying by the number of SELRES personnel that actually participated in ACDUTRA during the year. This calculation is illustrated in Table XV.

TABLE XV

## SELECTED RESERVE COMMISSARY BENEFITS ESTIMATION (FY 86)

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| UNIT      | NUMBER OF SELRES <sup>108</sup> x (SUBSIDY/26) = TOTAL (\$) |   |      |       |
|-----------|---|---|------|-------|
| Wadsworth | 11  |   |      | 53    |
| Duncan    | 107   | x | 4.83 | = 517 |
| Gray      | 2   |   |      | 10    |
| Lang      | 178   |   |      | 860   |

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## c. Navy Exchanges

Unlike the commissary store system, the Navy Exchange retail stores are not subsidized on a continuing basis. With the exception of exterior and grounds maintenance, Navy Exchanges have fiscal independence from the base facilities that they are co-located with. The minor costs of exterior upkeep are considered here as part of the fixed costs of base operations.<sup>109</sup>

## d. Medical and Dental Costs

The costs associated with the health care of Navy personnel have a direct effect upon the costs

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<sup>108</sup>Telephone interview with LCDR Wells, Naval Reserve Readiness Command, Region Nineteen, (Afloat Program Office), San Diego, California, 17 February 1987.

<sup>109</sup>Telephone interview with LT Smith, U.S. Naval Postgraduate School (Navy Exchange Officer), Monterey, California, 11 February 1987.



associated with the crews of all ships in the survey.

Military health care falls into three cost elements for the purpose of this thesis: medical treatment (in-patient and out-patient care), dental care, and Civilian Health and Medical Program of the Uniformed Services (CHAMPUS) assistance. Active duty personnel are costed at a per capita rate for services provided by medical and dental facilities serving the Long Beach and San Diego areas. Costs are based upon the average number of active duty personnel onboard, factored with the O & M budgets for clinics and the total visits or procedures that each of these agencies was called upon to perform during the year.

The technique used here to cost medical expenses for each unit is to first identify a Navy-wide average for outpatient care. Assuming that the behavior of active duty personnel assigned to the survey frigates mirrors the behavior of the Navy in general, average out-patient visits will be factored with the average crew complement and local naval hospital costs to identify the unit out-patient cost.

The average cost of medical treatment for patients at the Naval Hospital, San Diego was \$71 per visit

for outpatients and \$460 per day per bed. Corresponding values for the Long Beach Naval Hospital were \$69 per visit and \$636 per day per bed.<sup>110</sup> Local dental costs have been estimated by calculating the cost per dental procedure at each of the regional clinics. The cost factor in each case was the solely the operating and maintenance budget for the clinic for the fiscal year. Procedure costs for local dental clinics are computed in Table XVI.

TABLE XVI  
DENTAL CLINIC O & M BUDGETS (FY 86)

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| CLINIC                    | BUDGET (\$) | PROCEDURES | COST/PROCEDURE |
|---------------------------|-------------|------------|----------------|
| Long Beach <sup>111</sup> | 750,000     | 399,400    | 1.88           |
| San Diego <sup>112</sup>  | 1,494,697   | 600,504    | 2.49           |

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<sup>110</sup>Telephone interview with Mrs. Dobson, Naval Medical Command SW Geographic Region (Office of the ACOS for Resources), San Diego, California, 20 February 1987.

<sup>111</sup>Telephone interview with LT Trost, Long Beach Naval Dental Clinic, Long Beach, California, 14 January 1987.

<sup>112</sup>Telephone interview with CDR Stewart and DT1 Burdick, San Diego Naval Dental Clinic, San Diego, California, 19 January 1987.

The technique used here was to cost each member of the full-time crew for four out-patient visits and two dental clinical procedures per year. In addition, the full-time crew was credited for one ten-day inpatient period per 50 crewmen, representing a normal likelihood of injury or serious illness.

The CHAMPUS Program serves as a supplemental health care system available to active duty personnel and their dependents, when military health care facilities are not available or appropriate for the individual case. Using CHAMPUS operating data,<sup>113</sup> this thesis develops an average per capita cost of CHAMPUS benefits, net of program overhead costs. This value has then been multiplied by the number of full-time personnel to generate a unit CHAMPUS program cost.

Selected Reserve medical and dental costs are negligible for all but emergency visits. While SELRES serving onboard ship accrue these benefits, medical/dental authorities and unit commanders frown upon using precious drill time for any

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<sup>113</sup>U.S., Congress, House, Subcommittee of the Committee on Appropriations, CHAMPUS Program, 99th Cong., 1st sess., 1986, p. 1052.

medical treatment other than that required following shipboard accidents.<sup>114</sup>

Table XVII represents a compilation of costs for all personnel categories and the appropriate health care.

TABLE XVII

UNIT ESTIMATED MEDICAL AND DENTAL TREATMENT COSTS (\$)

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|           | OUTPATIENT | INPATIENT | DENTAL | CHAMPUS <sup>115</sup> |
|-----------|------------|-----------|--------|------------------------|
| Wadsworth | 37,454     | 17,262    | 510    | 64,559                 |
| Duncan    | 39,110     | 18,024    | 532    | 67,414                 |
| Crommelin | 62,376     | 28,748    | 850    | 98,005                 |
| Jarrett   | 54,096     | 24,932    | 736    | 93,247                 |
| Gray      | 50,866     | 23,442    | 692    | 87,681                 |
| Lang      | 52,108     | 24,016    | 710    | 89,822                 |
| Meyerkord | 77,248     | 25,024    | 1354   | 129,404                |
| Reasoner  | 81,508     | 26,404    | 1430   | 136,540                |

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<sup>114</sup>Telephone interview with CDR Lohr (Executive Officer), Long Beach Naval Dental Clinic, Long Beach, California, 5 February 1987.

<sup>115</sup>Using \$475.75 per service member per year, derived earlier.

The summary of unit base operating costs below represents all costs identified, with values then averaged and transferred to the Unit Cost Summary.

|            |           |            |           |
|------------|-----------|------------|-----------|
| Wadsworth: | \$209,711 | Gray:      | \$274,503 |
| Duncan:    | \$225,723 | Lang:      | \$349,545 |
| Crommelin: | \$320,348 | Meyerkord: | \$400,188 |
| Jarrett:   | \$292,625 | Reasoner:  | \$424,424 |

### 3. Comparative Analysis

Accuracy is an element that is extraordinarily difficult to capture in this sub-category. Defining precisely what costs should be affiliated with the survey group isolates only half of the problem; the remainder of the issue lies in finding accurate data that can be applied directly to the command in some fashion.

The Rand study group and the NPFM use average force strengths and Navy program budgets to identify the per capita costs that form their class-wide base operating costs. This technique is far from being exact, but it best serves its purpose; after all, to isolate the individual costs of all support facilities and then find the means of applying these to the entire class of ships would, in sum, be no better than the original simple plan.

This thesis localizes costs within the immediate



region, to attempt to capture regional peculiarities  
in support services.

#### IV. UNIT OPERATING COSTS

A natural division occurs in the analysis of the materials and facilities required to maintain a warship. The need (and as a result, the cost) for parts and supplies is continuous throughout the ship's life-cycle. While they may vary somewhat, the costs of equipment and stores that has just been considered are largely fixed. On the other hand, the remaining cost categories within the family have a strong variable element. In the remaining analysis, these costs will be identified and standardized for all units in the survey. These sub-categories include the following:

- A. PETROLEUM, OIL, AND LUBRICANTS (POL)
- B. TRAINING ORDNANCE AND EXPENDABLE TRAINING STORES
- C. UTILITIES
- D. UNIT PROVISIONS

##### A. PETROLEUM, OIL, AND LUBRICANTS (POL)

The elements in this category are largely variable costs representing the expenses incurred for fuel required for the main propulsion plant and various ship's equipments. Specific costs associated with lubricants are included in the Organizational and Maintenance Supplies sub-category.

To better understand how POL costs are generated, why they are variable, and (most importantly) why there exists a difference between total costs for NRF and active units, we must understand the operating behavior of a Navy warship. To this end, the following terms apply:

1. Steaming underway;
2. Steaming inport; and,
3. Cold iron operations.

All of the ships in the survey are continuously engaged in one of these three activities. Steaming underway refers to the operation of the unit at sea; the ship is clear of piers and support facilities, relying upon its own power to provide main propulsion and ancillary functions. Underway steaming involves the greatest expenditure of POL of the three conditions.

Steaming inport involves the operation of the ship's main engineering plant while inport. A condition that exists largely when tests, training, or pier utility maintenance is required, the ship is inport and has at least some dependence upon shore facilities for support even though it is sustaining itself in some measure.

POL expenditures are substantially lower than for underway steaming, but typically higher than for cold iron operations. While a ship is in cold iron, the main engineering plant and most supporting shipboard equipments are secured; the ship depends upon pier utility services for

electricity, fresh water, steam, and firemain services. To say that the dependence upon the pier is likely to eliminate POL consumption entirely is incorrect, however; pier utility services usually provide the medium for most shipboard activities to continue. Ship's equipment are tested and maintained, while shipboard pumps and electrical generators remain available (or in operation) to supplement pier support. POL consumption is substantially lower than either of the other two conditions.

It must also be noted that underway steaming is not uniform in its use of POL, either between ship operations or between ships. Some ship's operations make extensive use of the speeds at which fuel economy is greatest; passive anti-submarine warfare operations are one example. Other operations are equally important but impose a greater demand for POL; aircraft carrier plane-guard duties and battle group operations are typical examples. Fuel efficiency is also variable between ships because of the uniqueness of equipment, engineering plant efficiencies, and engineering plant management.

# 1. Current Studies Costing Techniques

## a. Rand Study Group

Schank and associates used data available to them on projected and actual steaming days, steaming hours, and annual, average fuel costs to derive a main propulsion fuel cost.

This costing technique is elaborate, but not all-inclusive or efficient. The study identified this method as excluding the cost of oil and lubricants, but did not explicitly treat either elsewhere.<sup>116</sup> Additionally, it cited the expenditure of fuel per steaming hour without considering the nature of the operations that the ships were involved in. Analysis later in this chapter will associate variable expenditures with the reasons for those expenditures. At the moment though, it is worth remembering that "efficiency" is not the same as "economy".<sup>117</sup>

The Rand model follows the characteristics of their model in the other sub-categories in that it has reasonable predictive value and can be applied to ships in both organizations.

b. VAMOSC

The VAMOSC itemized POL expended during the fiscal year, as reported monthly by individual ships to the Type Commander. These values were then costed, using the local purchase process. The costs are then forwarded to the Navy Cost Information System/Operations Subsystem (NCIS/OPS) and summed by unit for the year. These have then included in

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<sup>116</sup>Bodilly, Pei, and Schank, Unit Cost Analysis, p. 128.

<sup>117</sup>Bodilly, Pei, and Schank, p. 124.



VAMOSC data elements 1.2.1.1 and 1.2.1.2. Alternate fuel cost values can be derived by summing elements 1.2.1.1.1, 1.2.1.1.2, and 1.2.1.2.<sup>118</sup>

While the VAMOSC has no predictive capability, lacks data on NRF units, and is unavailable until some time after the end of the fiscal year in question, it does have several assets in this case:

- (1) It is simple and all-inclusive. Ships report their use individually, on a monthly basis. The accuracy of the data through the checks and reviews involved as it progresses through the chain of command are likely to be very high. Those POL costs not included in other equipment cost categories are included here.
- (2) Local fuel sources at current prices are used. Schank uses a summary fuel cost value that, while accurate for general use in some instances, may not reflect local costs, fluctuations in prices, or efficiencies of scale in the purchase or storage of petroleum products.

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<sup>118</sup> Commander, Naval Sea Systems Command (NAVSEA 017E2), VAMOSC, pp. A 9-16.

### c. Navy Program Factors Manual

The NPFM identified the average cost of fuel consumed by ship classes, using the price of POL in 1980.<sup>119</sup> Fluctuations in oil prices since 1980 are only part of the difficulty in using the NPFM for costing this sub-category; changes in the average operating tempo (OPTEMPO) of ships also go uncompensated.

### 2. Thesis Costing Technique

Data available for this thesis was drawn directly from the Navy Energy Branch (NOP-413), which monitors both fuel consumption by Navy units and the purchase process for fuels. The values listed in Table XVIII represent hours steamed in the three plant conditions of each ship which in part, reflects the distinction in ship's operating tempo and management policy. Fuel costs are estimated using the total barrels of fuel consumed, factoring for fuel prices at \$0.75 per gallon and 42 gallons to the barrel.

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<sup>119</sup>Office of the Chief of Naval Operations, Navy Program Factors Manual, p. 6.

TABLE XVIII  
UNIT FUEL CONSUMPTION DATA (FY86)<sup>120</sup>

|          | Hours |      |      | Barrels |      |     |       | Brls/Hour |      |
|----------|-------|------|------|---------|------|-----|-------|-----------|------|
|          | UND   | NUND | COLD | UND     | NUND | AUX | TOTAL | UND       | NUND |
| Gray*    | 1621  | 352  | 6115 | 27417   | 1806 | 139 | 29362 | 16.9      | 5.1  |
| Lang*    | 2116  | 765  | 5159 | 33822   | 4359 | 0   | 38181 | 16.0      | 5.7  |
| Meyerkd* | 1944  | 990  | 5106 | 24262   | 4715 | 48  | 29025 | 12.5      | 4.8  |
| Reasoner | 4289  | 1260 | 3211 | 82296   | 7403 | 0   | 89699 | 19.2      | 5.9  |
| Wadswrth | 1763  | 379  | 6618 | 19876   | 533  | 0   | 20409 | 11.3      | 1.4  |
| Duncan   | 1850  | 757  | 6153 | 12198   | 1727 | 0   | 13925 | 6.6       | 2.3  |
| Jarrett  | 2114  | 750  | 5896 | 26227   | 1081 | 59  | 27367 | 12.4      | 1.4  |
| Cromelin | 1628  | 1402 | 5730 | 17915   | 3252 | 1   | 21168 | 11.0      | 2.3  |

\* Eleven of twelve months of operating data available.

When the data from Table XVIII has been revised to reflect actual expenses, unit costs are as follows in Table XIX.

### 3. Comparative Analysis

Table XIX displays the total adjusted fuel expenditure of surveyed units. Table XVIII showed these same units in relation to the hours spent underway and additionally, those spent inport with the main engineering plant operating.

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<sup>120</sup>Telephone interview with LT Heinrich, Navy Energy Branch (NOP-413), Washington, D.C., 28 January 1987.

TABLE XIX<sup>121</sup>  
UNIT POL COST (FY86)

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|           | Data Costs | Adjusted Costs |
|-----------|------------|----------------|
| Gray      | 924,903    | 1,001,749      |
| Lang      | 1,202,701  | 1,310,406      |
| Meyerkord | 914,287    | 996,163        |
| Reasoner  | 2,825,518  | --             |
| Wadsworth | 642,883    | --             |
| Duncan    | 438,637    | --             |
| Jarrett   | 862,060    | --             |
| Crommelin | 666,792    | --             |

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Predictably, fuel costs varied with the steaming hours of the individual ship. The unit with the highest expenditure (Reasoner) also was the ship which conducted a Western Pacific deployment during FY 86. This ship logged 2.3 times the underway steaming hours of the median of the other ships in the survey.

The second characteristic that stands out is that the fuel efficiency of the FFG-7 class frigates as a whole far outweighs other potential factors in

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<sup>121</sup>Values have been averaged and transferred to the Unit Cost Summary on page 178.

comparing the fuel costs of all eight ships. The computed operating costs per underway steaming hour are listed in the following table:

TABLE XX  
SURVEY UNIT POL EXPENDITURES PER HOUR

|           | Costs / UND Hrs | Costs / (UND + NUND) Hrs |
|-----------|-----------------|--------------------------|
| Gray      | 570.58          | 468.78                   |
| Lang      | 568.38          | 417.46                   |
| Meyerkord | 470.31          | 311.62                   |
| Reasoner  | 658.78          | 509.19                   |
| Wadsworth | 364.65          | 300.13                   |
| Duncan    | 237.10          | 168.25                   |
| Jarrett   | 407.79          | 300.99                   |
| Crommelin | 409.58          | 220.06                   |

A third general observation is the significance that engineering plant management plays in the development of unit operating costs. While the operating tempo of the unit is largely beyond the control of the individual Commanding Officer, the consumption of fuel that occurs inport (in either of the other two plant conditions) is a variable over which the ship has much greater control. The maximum quarterly fuel



expenditure is still mandated by the Type Commander, but substantial flexibility remains in how much of this will actually be used. The fuel that is consumed inport is reflective of the operational readiness expectations, training programs, and fuel conservation viewpoints of each ship's engineering plant managers.

Once the factors that have already been considered are taken into account, there remains no discernible pattern between the amount of fuel consumed and the organization to which these ships are affiliated. It is clear that the fuel consumption patterns of seven of these ships are reasonably similar; the outlier was also the unit that deployed. Attributing higher fuel costs to the active units with no corrective factor for additional operating time would then unnecessarily bias the costing study; it should be apparent that a higher OPTEMPO would induce similar costs in the NRF unit's fuel equations. The means by which the corrective factor will be applied shall be treated later in this study.

## B. TRAINING AMMUNITION AND EXPENDABLE STORES

This sub-category incorporates the cost of gun ammunition, missiles, expendable pyrotechnics, and sonobuoys

that are consumed as a result of firepower demonstrations, training exercises, and equipment operational tests.

# 1. Current Studies Costing Techniques

## a. Rand Study Group

The Rand study group referred to VAMOSC for data. They assume that munitions consumption is fixed by ship class, and that this consumption is keyed to the ship's annual training ammunition allowance. This allowance was then costed by ammunition type and quantity to derive the average active cost. Using the same assumptions concerning consumption and allowance, Rand applied the same expenditure to the NRF units.<sup>122</sup> When used to project ship class ordnance consumption, this technique may have its merit. For the purpose of this identifying the specific costs associated with the ships in this survey, too many individual variables come into play to accurately reflect individual active duty or NRF ship consumption patterns.

## b. VAMOSC

VAMOSC incorporated all of the ammunition and sonobuoy expenditures referred to here under data elements 1.2.4.1 (Ammunition) and 1.2.4.2 (Other

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<sup>122</sup>Bodilly, Pei, and Schank, Unit Cost Analysis, pp. 132, 136, 137.

Expendables).<sup>123</sup> All ships are required to report ammunition expenditures to the Navy Ships Parts Control Center (SPCC) by way of the Conventional Ammunition Integrated Management System (CAIMS). VAMOSC received a summary cost evaluation from CAIMS for individual ship ammunition consumption. As a result, VAMOSC had the capacity to accurately measure the ammunition used by each unit within its purview. Unfortunately, the scope of VAMOSC analysis does not include NRF units.

c. Navy Program Factors Manual

The NPFM does not identify costs associated with ammunition consumption by either active duty or NRF ships.

2. Thesis Costing Technique

Data for this sub-category was provided by the COMNAVSURFPAC Ammunition Logistics Office. Because this office is an information addressee on all ammunition reports that originate from Pacific Fleet ships, the accuracy provided here is on a par with that available from the VAMOSC through the CAIMS system:<sup>124</sup>

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<sup>123</sup>Commander, Naval Sea Systems Command, VAMOSC, pp. A-23, A-24.

<sup>124</sup>Values have been averaged and transferred to the Unit Cost Summary on page 178.

Unit Non-Nuclear Ordnance Consumption (FY 86 Dollars)<sup>125</sup>

|            |         |            |         |
|------------|---------|------------|---------|
| Wadsworth: | 51,526  | Gray:      | 297,062 |
| Duncan:    | 51,705  | Lang:      | 269,194 |
| Crommelin: | 121,498 | Meyerkord: | 203,028 |
| Jarrett:   | 14,213  | Reasoner:  | 672,927 |

3. Comparative Analysis

Averaging the costs of all units in the class will not work unless the project goal is to provide long-term, class-wide cost analysis. The reason for this is that ammunition costs are largely variable --not fixed. While it is true that each ship receives an annual training allowance for munitions, the ship is not compelled to either expend all ammunition, or limit its consumption if waivers are requested.

The expenditure of ammunition and sonobuoys is closely linked to two critical variable activities --the period of time spent underway (during which time weapons systems PMS becomes due and weapons exercises take place) and circumstances in which expendible stores may be consumed. As an example of the first case, it should be obvious that the ship that is inport cannot fire its main gun or missile batteries--the locals would object. Even when the

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<sup>125</sup>Telephone interview with GMCM Bradley, COMNAVSURFPAC (Ammunition Logistics Office), San Diego, California, 13 February 1987.

ship is at sea, proximity to other ships, land, and small craft strictly limits consumption opportunities. In the latter case, exercises conducted in conjunction with ASW aircraft and submarines give cause for the judicious use of exercise torpedoes and sonobuoys, which may not otherwise be the case.

The allowance system does not reflect actual ship operations, or the non-availability of selected ammunition types. The last constraint is particularly felt where high unit price munitions like missiles, some gun ammunition, and selected sonobuoy types are concerned.

Another key element in the consumption patterns of each unit is the general philosophy that each ship's weapons systems management organization observes. Some ships make a special effort to schedule gun, missile, and torpedo exercises whenever the opportunity provides, in order to continually test the weapons systems and train personnel. In doing so, these units may exceed initial allowances in the course of the year; this problem is overcome by requesting more ammunition and a waiver for its legitimate use. On the other side, some ships only exercise their weapons systems in actual firings when fleet exercises or planned maintenance schedules



demand it. It should be clear here then that spending less on ammunition expenditures may certainly not be better than the alternative.

### C. UTILITY COSTS

In describing the costs included with petroleum, oil, and lubricants, it was introduced earlier that there were situations when the frigates had to draw resources from the pier in order to maintain "hotel" services --fresh, flushing, and firemain water, sewage discharge facilities, pressurized high-quality steam, electrical power, and telephone services.<sup>126</sup> These costs are predominantly variable; they are determined by the general characteristics of the ship, the amount of time that the ship spends inport relying upon these shore utilities, and the location of the ship when services are required.

#### 1. Current Studies Costing Techniques

##### a. Rand Study Group

The Rand study used VAMOSC data listed under "Utilities" to cost the active duty units' portion

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<sup>126</sup>This represents only the major purchases. Other expenses that fall into this category include selected hull and maintenance actions, charter and hire costs (garbage scow service, boat and vehicle rentals), communications services, printing and publication services, and other minor services.

of this sub-category. To cost the reserve portion, the Rand group assumed that:

- (1) Utility costs varied by the number of days spent inport.
- (2) The number of personnel onboard at any one time did not significantly affect utility costs.
- (3) The cost per hour for utilities at locations where active duty and NRF ships were berthed was approximately the same for all ships.

From these assumptions, Rand calculated the average utility cost per day, and by knowing average force values for steaming hours underway and not underway, the estimated days spent dependent upon pier services.<sup>127</sup>

The cost evaluation for active duty units is effective, since it represents the same accounting problem that both the VAMOSC and this thesis encounter. The reserve costing issue has potential flaws, based upon the conflict of assumptions and the variable factors that were introduced with this sub-category. This conflict will be examined in detail with the comparative analysis.

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<sup>127</sup>Bodilly, Pei, and Schank, Unit Cost Analysis, pp. 128-129.

b. VAMOSC

The data elements that now include utilities are summed under element 1.3 (Purchased Services). This element includes more specific costing segments, which incorporated printing and publication costs, rental of automatic data processing equipment and associated contractor support, rent, utility services, commercial communications services, and miscellaneous other support services not included elsewhere. Its comprehensiveness in summarizing active duty costs is offset by the absence of any NRF unit costing.<sup>128</sup>

c. Navy Program Factors Manual

The NPFM provides an annualized "average cost of the energy used to provide power (other than propulsion) to a ship in a particular class, that is not provided by the ship itself."<sup>129</sup> As a result, the value provided by the NPFM is extraordinarily limited in its scope, particularly when compared with other studies and this thesis. Add to this the fact that no units currently serving in the NRF are costed by the NPFM.

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<sup>128</sup> Commander, Naval Sea Systems Command, VAMOSC, pp. A 25-30.

<sup>129</sup> Office of the Chief of Naval Operations, Navy Program Factors Manual, p. 6.

## 2. Thesis Costing Technique

Data for this sub-category was provided by Code AFO-1, FAADCPAC<sup>130</sup> and the Budget Office of LBNSY.<sup>131</sup> All costs highlighted in the introduction to this sub-category are included here:

Unit Utilities and Services (FY 86 dollars)<sup>132</sup>

|            |         |            |         |
|------------|---------|------------|---------|
| Wadsworth: | 453,349 | Gray:      | 334,256 |
| Duncan:    | 180,398 | Lang:      | 330,063 |
| Crommelin: | 141,877 | Meyerkord: | 80,381  |
| Jarrett:   | 334,814 | Reasoner:  | 182,579 |

## 3. Comparative Analysis

The Rand study, VAMOSC, and this thesis all advocate use of utility expenditures as provided by individual active duty ships as an effective method of costing active units. Problems that emerge in costing this sub-category include the issues of comprehensiveness versus adequate segmentation, and treatment of Naval Reserve Force costs.

Adequate isolation of costs that are rightfully attributable to the individual ship is an issue that

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<sup>130</sup>E. S. Clemente, "Cost Spreadsheet for Selected Surface Ships," FAADCPAC Code AFO-1, San Diego, Ca., 1987.

<sup>131</sup>Telephone interview with Ethel Boykins, Long Beach Naval Shipyard (Budget Office), Long Beach, California, 6 March 1987.

<sup>132</sup>Values have been averaged and transferred to the Unit Cost Summary on page 178.

dominates the Base Operating Costs sub-category and as a result, it is treated in much more detail there. The problem in its simplest sense here is what to count as a ship's expense in the Utilities category. The Navy Program Factors Manual views this in the strictest sense; only fuel costs used for basic hotel services are incorporated, with ship class values for NPFM utilities. The Rand study group broadens the interpretation to include all services rendered that are not costed elsewhere, as do the VAMOSC and this thesis.

Where the Rand study suffers is in the philosophy that underlies their assumptions about comprehensive utilities costs. Were all ships to be berthed in stateside naval stations exclusively, then uniform costing values developed by Rand for NRF ships would be an accurate assessment of actual costs.<sup>133</sup> The truth of the matter is that the costs of utilities overseas are much higher than those stateside. While the ship tied up in San Diego has services provided automatically and at reasonable cost by Port Services, ships that venture into foreign ports oftentimes have to deal with indifferent consuls and profiteering chandlers to arrange for the basic amenities. Scow services, telephone connections,

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<sup>133</sup>Bodilly, Pei, and Schank, Unit Cost Analysis, p. 128.



liberty boat, and car rentals all amount to costs that exceed daily norms in American naval stations. Two implications arise from this: the first is that because NRF ships do not deploy, the costs that they incur for use of general utilities are likely to be less than the class average calculations that the Rand study would suggest. The second implication is that because active duty ships do deploy, their expected cost of utilities will not decrease as much as Rand proposes--if at all.

Deployers do have a higher OPTEMPO (predicting smaller utility costs), but the higher rates of foreign ports increase daily utility costs tremendously. USS Reasoner provides the best example of this among the surveyed ships: although underway 49 percent and steaming inport 63.3 percent of the year, its utility costs exceed those of USS Meyerkord (its active counterpart, whose similar operating figures were 24.2 and 36.5 percent) by more than \$100,000!

There are three point to conclude this sub-category with:

- a. Utility costs are not uniform, and 'average' utility costs are thereby suspect;
- b. When each particular stateside naval station is considered, the ship that spends more time in that

port will have a higher utility bill than its counterpart which spends more time at sea.

- c. Ships (either AD or NRF) that venture overseas will experience utility costs out of line with stateside averages.

#### D. UNIT PROVISIONS COST

The Basic Daily Food Allowance (BDFA) serves as a separate funding source to provision the ship with foodstuffs in support of the enlisted crew. It exists to replace the Basic Allowance for Subsistence in the compensation of the ship's crew. Although each enlisted man was allotted approximately \$3.70 per day for sustenance, the BDFA is not viewed as an element of compensation. It is instead a necessary cost of ship's fiscal operation, with a strong variable element.

1. Current Studies Costing Technique

No studies specifically address the issue of unit provisioning.

2. Thesis Costing Technique

This thesis uses the quarterly BDFA allowance values approved by the Navy Food Service System Office for FY 86.

While the BDFA for each ship has some nominal fixed cost (reflecting the preference of the crew to eat onboard and ship's management policy concerning

working hours and duty sections), a strong variable element exists for each ship because the ship's compensation for crew meals is determined solely by the number of sailors which subsist from the general mess; the following daily routine illustrates this. For each meal, a reliable petty officer (oftentimes the galley captain or master-at-arms) counts heads as sailors enter the "chow line". As each meal ends, the sum is forwarded to the Food Services Officer, where it is multiplied by a weighted proportion of the BDFA<sup>134</sup>.

While the cost associated with the summary BDFA value is strongly flavored by personal habits and preferences, it is dominated by the ship's operating tempo. Inport, sailors may opt for home cooking or retail 'fast food' purchases; underway, the general mess is the only place to subsist. BDFA costs vary with the ship's period at sea.

The ship's BDFA is limited by the number of enlisted personnel assigned to the command and present onboard, multiplied by the daily rate. It may be less, but it cannot be more than the maximum crew allotment. The Selected Reserve detachment increases the total number of personnel assigned during the

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<sup>134</sup>The BDFA is accounted for in the following proportions: 0.2 for breakfast, 0.4 for lunch, and 0.4 for supper.

period that they are on Inactive Duty Training or ACDUTRA.

The cost observed in feeding the ship's crew is a recurring, direct, fixed-variable element in the unit cost summary. All enlisted personnel assigned to sea duty are entitled to receive three meals per day at government expense.<sup>135</sup>

A number of considerations must be borne in mind, particularly when reflecting on the variable nature of this sub-category:

- a. The budget for unit provisioning is based upon two elements, the Basic Daily Food Allowance (BDFA) and the number of personnel present to take the meals.
- b. The BDFA is a standard unit cost developed quarterly by the Navy Food Service Systems Office (NFSSO). This office continuously monitors the costs charged to the Navy (and thereby, to the ship) for the provisions that become crew rations and applies an algorithm to establish the BDFA rate that will apply for the following quarter.
- c. Individual ships are responsible for counting the number of sailors that eat in the Enlisted Dining Facility (EDF) onboard. While the ship is

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<sup>135</sup>Officers subsist onboard at personal expense. As a result, the remainder of this category deals exclusively with enlisted personnel.

underway, all enlisted personnel onboard are counted for three meals per day. This is not an unreasonable estimate, since the EDF is the only restaurant available. Inport, sailors are counted as they pass through the "chow line" for each meal.

- d. The three daily meals do not carry equal weight in BDFA costing. The breakfast factor is  $(0.2) \times \text{BDFA}$ ; lunch:  $(0.4) \times \text{BDFA}$ ; and supper:  $(0.4) \times \text{BDFA}$ . These meal factors are multiplied by the number of sailors participating to derive the standard costs for each meal.

The variable element in provisions costing is accentuated by the fact that dining onboard may be inconvenient or undesirable while the ship is inport; it is a necessity while the ship is underway. Sailors living ashore usually arrive as the EDF is securing in the morning and predictably elect to eat with family or friends ashore at the end of the working day. Interestingly, some sailors do not eat lunch inport because it is prepared as a balanced meal --snacks and 'fast foods' are not part of the norm in Navy meal planning. Consequently, the percentage of



the crew that eats while inport is substantially less than while the ship is at sea<sup>136</sup>.

The costs reflected in the following data very closely approximates those costs experienced by each unit in feeding its crew.

Basic Daily Food Allowance (FY 86) (dollars)<sup>137</sup>

| <u>OCT - DEC</u> | <u>JAN - MAR</u> | <u>APR - JUN</u> | <u>JUL - SEP</u> |
|------------------|------------------|------------------|------------------|
| 3.73             | 3.51             | 3.76             | 3.51             |

Unit Provisions Costs (FY 86) (dollars)<sup>138</sup>

|           |         |           |         |
|-----------|---------|-----------|---------|
| Wadsworth | 166,705 | Gray      | 184,116 |
| Duncan    | 153,098 | Lang      | 212,632 |
| Jarrett   | 194,296 | Meyerkord | 247,211 |
| Crommelin | 165,822 | Reasoner  | 269,356 |

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<sup>136</sup>In an informal survey conducted by the author of officers and senior enlisted personnel with shipboard food service experience, most observed between 90 and 100 percent participation at meals while underway. Estimates of participation at meals inport varied more, but most agreed with the following observations (as a percentage of total crew assigned): breakfast: 33-60; lunch: 33-70; and supper: 25-45.

<sup>137</sup>Telephone interview with MSC Carellon, U.S. Naval Postgraduate School (Enlisted Dining Facility), Monterey, California, 9 January 1987.

<sup>138</sup>Telephone interview with Mrs. Reinhart, Navy Food Service Systems Office, Washington, D.C., 14 January 1987.

## E. OPERATING VARIABLE COSTS CORRECTION

Several of the cost sub-categories that we have evaluated have dealt with an interesting--and unanswered --question: If, in the course of their assigned duties, one group of ships had a different operating routine from another, and if in that operating routine additional costs were imposed, then how is the inequality treated? The specific issue that we must deal with refers to the recurring, variable costs of POL and other materials consumed at higher levels with greater operating time.

The Rand study group made it clear that active duty ships were, in most operating categories, at least as expensive to maintain as their reserve counterparts.<sup>139</sup> How much of this was due to being at sea for a longer period?

This section seeks to deal with the question of whether NRF ships are cheaper to operate than active ships. To do this, it is necessary to ensure that the units that we are evaluating have commonality in the nature of how their costs are incurred. Active duty ships deploy periodically; in the preparation and execution of this, a lot of time is spent at sea, and more variable costs are incurred than deferred. NRF ships remain close to their homeports; utility costs<sup>140</sup> are higher, but other costs are lower for operations. In the

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<sup>139</sup>Bodilly, Pei, and Schank, Unit Cost Analysis, p. 137.

<sup>140</sup>Bodilly, Pei, and Schank, p. 137.

course of their operations, NRF ships help to train one (and sometimes two) SELRES crews. The points here are that:

1. The ships of both organizations endeavor to meet Navy objectives for their employment; and,
2. The operating costs differ, as a result. Table XXI uses the operating data from Table XVIII to display the differences in operating activity that the survey ships experienced in FY 1986:

TABLE XXI  
UNIT OPERATING PERCENTAGES

|           | <u>Underway/Total</u> | <u>(Underway + Not Underway)/Total</u> |
|-----------|-----------------------|--|
| Gray      | 20.04                 | 24.39                                  |
| Lang      | 26.32                 | 35.83                                  |
| Meyerkord | 24.18                 | 36.49                                  |
| Reasoner  | 48.96                 | 63.34                                  |
| Wadsworth | 20.13                 | 24.45                                  |
| Duncan    | 21.12                 | 29.76                                  |
| Jarrett   | 24.13                 | 32.69                                  |
| Crommelin | 18.58                 | 34.59                                  |

The costs differ, but we seek to establish an equitable cost comparison. An adjustment to the cost equation is necessary to do this. There are two ways available:

- a. Determine the additional costs necessary to operate an NRF ship in an active duty ship's schedule; or,
- b. Determine the cost adjustments necessary to operate an active duty ship on an NRF ship's schedule.

Which way is better? The author chooses to ask a simpler question here: which way is more practical? For the first alternative, deploying a ship for six months would require the continuous presence of one SELRES crew which, given that they are only available for two weeks apiece for ACDUTRA, demands 26 different detachments. This alternative is ludicrous; costs of pay, plus additional logistic and transportation costs would sky-rocket. The crew, rather than being battle-ready, would be weary and largely unfamiliar with their temporary surroundings. The second alternative, to calculate costs based upon a common scale using the NRF schedule, is infinitely more workable. The key to this problem, after all, is not to find out how high we can make units manning costs go; it is to adjust the variable costs of equipment operation. Manning costs should not change at the NRF scale.

## 1. Current Studies Costing Techniques

### a. Rand Study Group

This study introduced the variable nature of POL and certain equipment costs, but did not include a common operating cost factor of the nature discussed here.

### b. VAMOSC

The VAMOSC deals strictly with costs incurred and does not develop alternate costs or provide a method by which these costs may be estimated.

## 2. Thesis Costing Technique

The actual operating schedules for the eight surveyed ships were evaluated for FY 1986.<sup>141</sup> All operating time was placed in one of six operating classifications:

### a. Overhaul/SRA/PMA

To belong in this category, the ship was engaged in higher-level maintenance. Variable operating costs are minimal; variable utility (caretaking) costs are relatively higher.

### b. Inport and Upkeep

This category includes time spent pierside conducting routine maintenance and activities.

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<sup>141</sup> Commander Naval Surface Forces Pacific, "Quarterly Operational Schedules, Fiscal Year 1986," San Diego, Ca., 1986.



Concurrent inspections and tests may be underway (including Mobile Training Team visits and type training inport). The engineering plant is secured, with low variable operating costs and higher variable caretaking costs.

c. Port visits overseas

Similar to inport activities above, this category includes port visits at anchor or pierside overseas. Variable costs of operation tend to be higher than stateside; engineering plants are at a higher condition of readiness and, in the case of FF-1052s, at least one boiler well be operating continuously. Accordingly, variable caretaking costs tend to be lower than for stateside inport activities.

d. Inspections

The primary employment of the unit during the time specified, this includes major operational inspections that stress operational readiness and unit skills.<sup>142</sup> Variable operating costs are higher; more time spent at sea, with inport time spent in a

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<sup>142</sup>These inspections include the Nuclear Weapons Technical Inspection (NWTI), Operational Propulsion Plant Examination (OPPE), and Refresher Training (REFTRA).

steaming condition. Variable caretaking costs are at the norm or lower.

- e. Independent steaming, transits, and local operations.

The ship is operating at sea, conducting independent drills and systems training. Variable operating costs are higher; caretaking costs are at a minimum.

- f. Underway exercises

The ship is operating at sea, on specific assignments or in company with other ships. Variable operating costs are higher; variable caretaking costs at a minimum.

The unit costing model is closely linked to the operating schedules of the ships selected for two very critical reasons. The first reason is that the ship that spends more time at sea costs more to operate, if for no other reason than because the cost of ship's fuel and lubricants are higher than the cost of utility services available while inport. Previous studies have highlighted the average costs of operation and maintenance, but do not associate these costs in any manner to the operating tempo of the ships.

In the studies that this thesis has evaluated it has been a common point that the difference in operating tempos is observed but not adjusted for. To make a

valid costing comparison, the operating behavior of both organizations' ships must be made equal and then compared.

To develop an equal relationship, the following technique is used:

a. Identify the standard correction

Unit costs in four of the sub-categories examined by this chapter will be corrected. The corrective factor represents the difference between the standard operating days or hours, and those that were actually observed during the year.

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Steaming hours standard correction for POL consumption:

$$(14.7 \text{ days/qtr} \times 4 \text{ qtrs} \times 24 \text{ hrs/day}) = 1411.2 \text{ hrs/yr}$$

Underway days standard correction for Ordnance expenses and Provisions expenses:

$$(14.7 \text{ days/qtr} \times 4 \text{ qtrs/yr}) = 58.8 \text{ days/yr}$$

Standard hours correction for Utilities expenses:

$$(365 \text{ days/yr} \times 24 \text{ hrs/day}) - 1411.2 = 7348.8 \text{ hrs/yr}$$

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b. Identify actual days or hours that the unit spent in the operating condition that induced the variance from the standard operating value:

(1) POL expenses resulted from operating the main propulsion system. The following values reflect the hours that each of the survey units spent underway, or in an inport steaming condition:

|            |      |            |      |
|------------|------|------------|------|
| Wadsworth: | 2142 | Gray:      | 2137 |
| Duncan:    | 2607 | Lang:      | 3139 |
| Crommelin: | 3030 | Meyerkord: | 3197 |
| Jarrett:   | 2864 | Reasoner:  | 5549 |

(2) Expenses for use of training ordnance, expendable stores, and provisions occurred largely as a result of days spent actually underway. The following values represent the sum of days spent participating in exercises or independent steaming:

|            |     |            |     |
|------------|-----|------------|-----|
| Wadsworth: | 87  | Gray:      | 66  |
| Duncan:    | 85  | Lang:      | 126 |
| Crommelin: | 80  | Meyerkord: | 105 |
| Jarrett:   | 109 | Reasoner:  | 216 |

(3) Expenses for utilities consumed occurred while the unit was inport. The following values represent the number of hours that each ship spent not underway:

|            |      |       |      |
|------------|------|-------|------|
| Wadsworth: | 6997 | Gray: | 7004 |
| Duncan:    | 6910 | Lang: | 6455 |

Crommelin: 7132                      Meyerkord: 6642

Jarrett: 6646                      Reasoner: 4471

- c. Generate variance factors for each unit in each sub-category. The variance factor is formulated by dividing the standard value for each sub-category by the actual value observed for each unit:

TABLE XXII  
UNIT VARIANCE FACTORS

| UNIT      | POL     | ORDNANCE | PROVISIONS | UTILITIES |
|-----------|---------|----------|------------|-----------|
| Wadsworth | .658824 | .675862  | .675862    | 1.050279  |
| Duncan    | .541312 | .691765  | .691765    | 1.063502  |
| Crommelin | .465743 | .735000  | .735000    | 1.030398  |
| Jarrett   | .492737 | .539449  | .539449    | 1.105748  |
| Gray      | .660365 | .890909  | .890909    | 1.049229  |
| Lang      | .449570 | .466667  | .466667    | 1.138466  |
| Meyerkord | .441414 | .560000  | .560000    | 1.106414  |
| Reasoner  | .254316 | .272222  | .272222    | 1.643659  |

- d. Multiply variance factors by corresponding data values to identify unit standard costs in each sub-category. Standard values have been calculated for each unit, with the average value underneath that of the actual value in the Unit Cost Summary.



## V. UNIT COST SUMMARY

The unit cost summary is the final equation that links all of the individual elements of the three costing families together and allows a summary cost comparison between AD and NRF ships.

|                         | FF-1052   | FF-1052   | FFG-7     | FFG-7     |
|-------------------------|-----------|-----------|-----------|-----------|
|                         | AD        | NRF       | AD        | NRF       |
| <u>MANPOWER COSTS</u>   |           |           |           |           |
| Basic Pay               | 5,196,771 | 5,001,484 | 4,351,792 | 3,370,755 |
| Reserve Costs           | --        | 68,240    | --        | 42,117    |
| Travel Costs            | 218,991   | 203,000   | 162,457   | 145,240   |
| <u>Initial Training</u> | 650,206   | 719,797   | 444,673   | 515,769   |
| Career Pay              | 362,541   | 318,392   | 254,067   | 251,862   |
| Retirement Costs        | 1,646,478 | 1,457,353 | 1,379,870 | 1,134,317 |
| <u>Sub-total</u>        | 8,074,987 | 7,768,266 | 6,592,859 | 5,460,060 |
| (%)                     | 100%      | 96%       | 82%       | 68%       |

### UNIT MAINTENANCE COSTS

|                    |         |           |           |           |
|--------------------|---------|-----------|-----------|-----------|
| O & M Supplies     | 254,150 | 373,200   | 326,600   | 284,200   |
| Repair Parts       | 738,400 | 430,150   | 968,550   | 1,046,200 |
| Higher Maintenance | 726,910 | 3,937,836 | 2,034,611 | 824,226   |
| Base Costs         | 412,306 | 312,024   | 306,487   | 217,717   |

|                  |           |           |           |           |
|------------------|-----------|-----------|-----------|-----------|
| <u>Sub-total</u> | 2,131,766 | 5,053,210 | 3,636,248 | 2,372,343 |
| (%)              | 100%      | 237%      | 171%      | 111%      |

UNIT OPERATING COSTS

|            |           |           |           |           |
|------------|-----------|-----------|-----------|-----------|
| POL        | 1,910,840 | 1,156,077 | 764,426   | 540,760   |
|            | (561,077) | (575,736) | (367,662) | (330,493) |
| Ordinance  | 437,977   | 283,128   | 67,855    | 51,705    |
|            | (148,441) | (195,140) | (48,484)  | (35,296)  |
| Utilities  | 131,480   | 332,160   | 238,346   | 316,874   |
|            | (194,516) | (363,239) | (258,205) | (333,999) |
| Provisions | 258,283   | 198,374   | 180,059   | 159,901   |
|            | (105,882) | (131,630) | (123,811) | (109,289) |

|                  |           |           |           |           |
|------------------|-----------|-----------|-----------|-----------|
| <u>Sub-total</u> | 2,738,580 | 1,969,739 | 1,250,686 | 1,069,240 |
| (%)              | 100%      | 72%       | 46%       | 39%       |

|                       |           |           |         |         |
|-----------------------|-----------|-----------|---------|---------|
| <u>Standard Costs</u> | 1,009,916 | 1,265,745 | 798,162 | 809,077 |
| (%)                   | 100%      | 125%      | 79%     | 80%     |

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|                       |            |            |            |           |
|-----------------------|------------|------------|------------|-----------|
| <u>SHIP UNIT COST</u> | 12,945,333 | 14,791,215 | 11,479,793 | 8,901,643 |
| (%)                   | 100%       | 114%       | 89%        | 69%       |

|                      |            |            |            |           |
|----------------------|------------|------------|------------|-----------|
| <u>STANDARD COST</u> | 11,216,669 | 14,087,221 | 11,027,269 | 8,641,480 |
| (%)                  | 100%       | 126%       | 98%        | 76%       |

## VI. CONCLUSIONS

This chapter is composed of three sections, which are closely related to the initial objectives of the thesis. The first section, Unit Cost Analysis, briefly summarizes the findings of the cost research done here earlier. The second section, Costing Studies Critique, provides a concise analysis of the studies that this thesis has reviewed. The final section, Observations, relates this work and its findings to the current environment and briefly discusses issues that affect the ship manning question.

### A. UNIT COST ANALYSIS

Among the initial questions that this thesis posed asked whether the transfer of frigates from the active force to the NRF resulted in additional indirect costs to the organization that lost these assets. These costs were presumed to arise through lower retention and higher variable costs because of more time spent at sea.

The answer to this question, based upon the research conducted here, is 'no'. Transfer of units to the NRF has come at the same time as the Navy's celebrated expansion to a '600 ship fleet'. This has also coincided with fewer Indian Ocean ship commitments, as Middle Eastern tensions

have stabilized. As a result, Regular Navy ships assigned to the Third Fleet actually spent fewer days per quarter at sea than they did in past years.

#### 1. Manpower Costs

Within this family, values for each sub-category for the FF-1052 class were close for both organizations units, largely because of the number of full-time crewmen assigned to the NRF units. Manning costs for the NRF FF-1052s averaged 95% of their active duty counterparts. A much greater separation existed between the FF-1052 and FFG-7 frigates; predictably, the economies taken in planning personnel billets for the Perry class made these frigates substantially cheaper to man than either the Regular Navy or NRF Knox class ships. Additionally, there was a substantial cost difference in manning the FFG-7s; within this survey, it only cost 80 cents on the dollar to man the NRF ship, in comparison with the active unit. Given the present manning policies in effect in the Navy, very little savings are observed in manning the FF-1052 class with Reservists. On the other hand, transferring FFG-7s to the NRF appears to have a substantial impact upon the observed manpower budget.

#### 2. Unit Maintenance Costs

The results observed in costing this family yielded many surprises. The labor-intensive AD FF-1052

generated an average cost at or below those of the other ship classes in the survey. The one instance in which average costs were exceeded by the AD FF-1052 came as a result of the Base Operating Costs sub-category, which was heavily flavored by Navy-wide averaging and actual manning values.

As a ship class, the FFG-7 proved to be substantially more expensive in the Repair Parts sub-category than the FF-1052s. This result is consistent with the degree of sophistication associated with this newer ship system, and in keeping with the higher average costs that result from replacing "black boxes" in the maintenance cycle, rather than the cheaper, traditional process of repairing ship's equipment components onboard.

The higher-level maintenance conducted on ships and weapons systems proved to factor heavily in the overall costs of this family. Little analysis can be done within the time period of a single year--other than to reiterate that higher-level maintenance is conducted at a premium price. More effective maintenance comparisons may be accomplished by gathering data over the course of the maintenance cycles of these ships--a period of six to ten years.



### 3. Unit Operating Costs

The purpose in developing and applying the standard cost algorithm to the observed costs for each ship class was to first consider the actual costs of operation, and to then consider costs once more after the effects of a ship's sea time had been neutralized.

As was expected, there was a direct relationship between a ship's steaming hours and costs of POL, ordnance, and provisions; an inverse relationship existed between hours at sea and the cost of utilities.

As a ship class, the FFG-7 demonstrated the superiority of its gas turbine engineering plant through POL costs that were far lower than those of the FF-1052 class. Ordnance costs for the year were much higher for the FF-1052s as a class. Utilities costs were higher for NRF ships than their AD counterparts, considering both actual and standard costs. Provisioning AD units cost more than it did for NRF ships; the influence of this cost behavior appears strongly related to the sea time of each of the ships.

Among the operating costs observed here, several results emerge:

- a. The FFG-7 class operates at a fraction of the price of the FF-1052, regardless of organizational affiliation.
- b. Actual costs associated with AD ships are higher than those of NRF ships.
- c. When costs are standardized, the NRF FF-1052 costs more to operate than the AD ship of this class. Operating costs of AD and NRF FFG-7s are almost identical.

#### 4. Total costs

Within this survey group, it cost 14 percent more to operate NRF FF-1052s than it did to operate the AD ships of this class. By contrast, FFG-7s operated at 76 percent of the costs observed by the AD units of this class.

### B. COSTING STUDIES CRITIQUE

#### 1. VAMOSC

It has been stated repeatedly throughout this thesis that the VAMOSC provided (what appeared to be) an accurate, comprehensive, historical assessment of costs associated with active duty units. It is clear that a data management system exists here that can effectively provide summary cost data on more than 500 naval units with a wide variety of missions and

expenditures. Why then are Naval Reserve Force ships excluded from this analysis?

The author of this thesis spent months 'reinventing the wheel' in developing a summary cost algorithm that has used a common source of data for both organizations' ships. The result is accurate, but it is not the same wheel that personnel at NAVSEA 017E or their contractor, Information Spectrum, Inc., have developed. Ancillary cost assessments and segmentation methods will differ with each author's view of what should and should not be included, and such will certainly be the case here when the FY 1986 VAMOSC is published.

The charter of the VAMOSC should be expanded to incorporate NRF units, using the same costing philosophy as is used for their active counterparts. Even though much of the data required is now available to VAMOSC editors, there is no indication that the current 'active duty-only' analysis will be expanded. For the sake of providing an accurate, comparative reference on the subject, this policy should change.

## 2. Navy Program Factors Manual

This document provides an interesting view of how the Service costed its ships and aircraft in 1980, but it is now badly behind the times. The data or estimates

that were originally used to develop the specific cost categories are not clearly defined in the text and as a result, the reader is left to wonder how changes in manpower compensation, operational policies, and POL costs may have affected each entry. The NPFM was originally intended for general planning purposes rather than for actual budgeting and these figures were then to be used solely to reflect class-wide behavior. That there is no reference to contemporary NRF units condemns the NPFM for use in a comparative analysis of this type.

The Navy Program Factors Manual proved to be outdated and much too general in its approach to be of any value for effective analysis. The opposite was true of the Economic Analysis Report; the format and specificity of this work made it easy to use. As a reference guide for almost any element associated with a Navy manpower problem, this work has comprehensive, but detailed analysis.

In looking for a thoughtful, comprehensive costing analysis that incorporates predictive analysis, the best source is the Rand study (Unit Cost Analysis). While the author of this thesis has found many reasons to disagree with Rand's methodology, it is an excellent work for the comprehensive sample that it seeks to analyze. The techniques explained here

provided many insights in developing a small-sample study.

## C. OBSERVATIONS

This thesis has introduced three techniques in comparative unit costing that are worth reviewing:

### 1. Annualized costs

A comparative analysis is only valid if costs are segmented by time, as well as organization. This concept was particularly important as the thesis explored the costs of manpower bonuses and training.

### 2. Actual costs

This thesis benefited from having a sample size small enough to identify costs that were actually incurred during the year by each of the survey ships. The differences between actual manning and the alternate costing methods proved to be particularly important as costs were evaluated.

### 3. Standard Operating costs

This thesis introduced the notion that the variable costs associated with ship operating time may heavily influence the costs observed in some sub-categories. Among the difficulties that spring forth when units from two essentially independent organizations are compared is to find a reason for the comparison. What should then follow is a search for common values that



allow the comparison to take place. This is particularly important when evaluating the Regular Navy with the Naval Reserve Force. The role of the Regular Navy is to provide an instantaneous response, with trained professionals, in support of national policy. This mission is not the same as that which the Naval Reserve is chartered for, which is to provide sustained support for a naval campaign based upon an optimum use of the nation's mobilized resources. This thesis has gone into depth concerning the funds required by each organization to sustain their ships, but has not considered the merit of retaining two parallel organizations.

Time is linked closely with readiness in the configuration of the nation's naval policy. To illustrate this, consider that if neither was considered important, then no standing navy would be required.

Maintaining the Regular Navy affords the nation an instantaneous response when its leaders deem it necessary. Retaining a Naval Reserve provides the machinery for a timed response, where large numbers of men and ships are required for combat some time after the initial mobilization call. Optimizing these two policies simultaneously is far more important than seeking optimization at the lower level associated with individual ship costing.

This thesis represents a cost analysis of one small segment of both the active navy and the Naval Reserve Force. Its value lies not so much in its 'bottom-line' which, by the time that you read it, will be little more than an interesting historical oddity. Its worth rests in the methodology; how the technique was derived and how it can be updated and improved.

APPENDIX A  
HISTORY AND ORGANIZATION  
OF THE NAVAL RESERVE FORCE

The rapid mobilization of manpower and resources in 1940 introduced the trial-by-fire of American naval reservists in a truly broad arena. The expansion of the Navy in the ensuing years rapidly overtaxed the limited resources of the Navy's prewar active duty cadre, demanding an immediate influx of naval reservists into all elements of the Service. The later war years saw no less than 75 percent of the Navy's billets filled by Naval Reservists.

The success of Reserve participation in the war, coupled with the presence of far more newly-commissioned destroyers and escorts than the postwar active duty forces needed, gave rise to the transfer of combatants to the Naval Reserve Force. The primary purpose for this transfer was to allow Naval Reservists to remain aware of modern warship maintenance and operations through "hands-on" training.

The formula that developed called for the assignment of combatants to the Naval Reserve Force in ports located close to major regional population centers. A small cadre of active duty personnel would maintain the ships on a daily basis. Naval Reservists would alternately train at their

local Naval Reserve Center ashore, and onboard the ship while it was either underway or inport. The training would be held one weekend every month. Once each year, the Naval Reserve detachment would embark on their assigned ship for two weeks of intensive active duty training (ACDUTRA).

Introduction of "modernized" WWII destroyers<sup>143</sup> of the Gearing and Carpenter classes took place after 1969, to replace aging destroyer escorts that were not considered worth upgrading. NRF strength built to approximately 30 ships soon thereafter. This strength remained fairly constant through the following decade, with the original mission, to train assigned SELRES personnel, largely unchanged.

The development of highly sophisticated weapons systems after World War II made the continued use of the FRAM destroyers in reserve service a stopgap measure at best; the ships were vulnerable to potential adversaries of both principal and lesser navies, despite the improvements that had been made to them since 1945. Additionally, the men assigned to these obsolete platforms would require substantial retraining before they might be reassigned to more modern warships in the event of mobilization. In assigning these personnel to platforms that did not allow them to

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<sup>143</sup>Selected Gearing and Carpenter class destroyers had undergone modest overall improvements and became known as FRAM (Fleet Rehabilitation And Modernization) destroyers.

maintain their proficiency in state-of-the-art naval technology, much of the original value of their active duty training was allowed to go to waste.

TABLE XXIII  
NAVAL RESERVE ORDER OF BATTLE, 1976 - 1984

| Ship Class | Fiscal Year |    |    |    |    |    |    |    |    |
|------------|-------------|----|----|----|----|----|----|----|----|
|            | 76          | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 |
| Gearing    | 32          | 28 | 27 | 26 | 25 | 17 | 7  | 4  | 2  |
| Carpenter  | 2           | 2  | 2  | 2  | 2  | 2  | 1  | 0  | 0  |
| Edson      | 0           | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  |
| Knox       | 0           | 0  | 0  | 0  | 0  | 0  | 4  | 6  | 6  |
| Perry      | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 3  |
| TOTALS     | 34          | 31 | 30 | 29 | 28 | 20 | 13 | 11 | 12 |

Selection of the FF-1052 and FFG-7 classes as successors to the FRAMs began in the late 1970s as the Navy sought to resolve a dual problem: ridding itself of the nearly worthless FRAMs (before Congress insisted upon their overhaul for continued service) and finding an adequate replacement for Naval Reserve training. Table XXIII illustrates the transition from the FRAM destroyers to FF-1052 and FFG-7 class frigates. Efforts to reduce reserve force strength by 40 percent in the latter half of the



decade failed; Congress repeatedly made itself clear that it wanted a Naval Reserve, and the Navy was to find a way to make the mandate work.

The solution glimmered briefly in 1979 and 1980 as the Navy proposed the construction of a small ASW frigate (known during its short lifespan as FFX). Originally devised to supplement the FFG-7 class as a marginally effective (but inexpensive) ASW ocean escort for use in low-threat areas, the FFX class was to have been turned over for operation by the Naval Reserve Force immediately after commissioning. Original plans called for twelve of these ships to be constructed, with initial construction to begin in FY 84.<sup>144</sup> The plan drew immediate and relentless criticism from both Houses of Congress when the administration requested \$15 million for advance planning funds. The House Armed Services Committee summarized Congress's opinion by stating (somewhat surprisingly) that capability rather than cost should determine weapons design, and that the FFX as proposed was "sacrificing combat power to artificial cost limits."<sup>145</sup>

As the destroyers that the reservists were assigned to continued to age, the Navy looked to the surface combatants then in service and production for potential transfer to the NRF. The roles that their predecessors in World War II

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<sup>144</sup>Norman Polmar, The Ships and Aircraft of the U. S. Fleet (London: Arms and Armour Press, 1985), p. 176.

<sup>145</sup>Congressional Quarterly Almanac, Inc., Congressional Quarterly Almanac, 1981, p. 219.

played were still important, four decades later. Among these were:

1. Defending Sea Lanes of Communication (SLOC) against interference;
2. Providing convoy escort services for amphibious assault forces; and,
3. Providing escort services for underway replenishment groups.<sup>146</sup>

The characteristics of these duties seemed ideally suited to both the new classes of frigate and the Naval Reserve. Increased naval activity to project power overseas and to support our allies would fully tax the resources of the Regular Navy, which would be employed on priority assignments, supporting carrier battle and surface action groups in offensive operations. The ships that would fill the convoy escort roles would have to face a balance of requirements and restraints (despite Congress's appearance of generosity); while being able to counter the medium- and low-level continuous threat of a first- or second-rate adversary, the frigates must have a unit price low enough to provide high volume output from American shipyards, with a pricetag palatable to Congress.

In 1981 the Naval Reserve ASW Frigate Implementation Plan was presented to Congress. This proposal by the Navy called for the transfer of twelve FF-1052 class frigates to

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<sup>146</sup>Polmar, Ships and Aircraft of the U. S. Fleet, p. 160.

the Naval Reserve by 1986. The Plan was later modified in the same year to provide for the transfer of the first FFG-7 class frigates then constructed to the NRF, in order to build to a reserve force level of 24 modern warships. The Plan was further modified in 1982 with the projected transfer of 8 FF-1052s and 16 FFG-7s to the Naval Reserve in lieu of previous proposals. Furthermore, two additional FFG-7s were to be transferred to the NRF to coincide with the commissioning of the battleship Wisconsin battle group in Corpus Christi, Texas in 1990.<sup>147</sup>

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<sup>147</sup>Office of the Chief of Naval Operations, Report to the Congress on the Navy's Total Force, Fiscal Year 1987, (1986).

## APPENDIX B

### SHIP CLASS CHARACTERISTICS

The ships selected for transfer with the inception of the NRF ASW Implementation Plan have come from the two largest ship classes constructed in the postwar United States.

The frigate<sup>148</sup> has been, since World War II, a primary ship type designed to escort convoys in medium- and low-threat areas. With this purpose in mind, both the Knox and Perry classes are well-suited for the task. Although limited in their designed speed (maximum 27-30 knots) to keep up with carrier battle groups, these ships have both the endurance and speed to serve a convoy commander's needs. Table XXIV displays the projected frigate order of battle of the Regular Navy and Naval Reserve Force for the next decade.

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<sup>148</sup>To avoid confusion, the ship classification 'frigate' will be used to identify those ship classes which, until the early 1950s were known as 'destroyer escorts' and until 1975 as 'ocean escorts'.

TABLE XXIV

PLANNED FRIGATE FORCE COMPOSITION FY 86 - 94<sup>149</sup>


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| Fiscal Year | 86  | 87  | 88  | 89  | 90  | 91  | 92  | 93  | 94  |
|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Active      | 98  | 96  | 91  | 92  | 90  | 90  | 90  | 89  | 88  |
| Reserve     | 15  | 19  | 24  | 24  | 26  | 26  | 26  | 26  | 26  |
| Total Force | 113 | 115 | 115 | 116 | 116 | 116 | 116 | 115 | 114 |

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## A. FF-1052 (KNOX) CLASS

This class numbers 46 ships, commissioned between 1969 and 1974. A high endurance ship, comparable in size to a World War II destroyer leader, the Knox class frigate possesses an extraordinarily potent ASW suite. In much the same manner that their World War II predecessors were called upon to protect convoys against German U-Boat and Japanese I-Boat threats, these ships have been built and modernized to counter the immense Soviet force. Their weapons systems are matched for this purpose with the capacity to maintain one LAMPS Mark I torpedo-bearing helicopter. The ship itself

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<sup>149</sup>Office of the Chief of Naval Operations, Report to the Congress, 1987, p. 72.



has both rocket-thrown (ASROC) and ship-launched ASW torpedoes.

The Knox class has a modest anti-surface raider capability with HARPOON missiles and a five-inch multi-purpose gun mount. Its anti-air warfare capability is meagre, with the 5" gun and either the Close-In Weapons System (Vulcan Phalanx) or NATO Seasparrow missile systems for proximity defense.<sup>150</sup>

#### B. FFG-7 (OLIVER HAZARD PERRY) CLASS

The Perry class was designed and built to retain much of the potency of the Knox class's ASW outfit while strengthening the anti-air warfare capabilities of the escort. To this end, the Perry class is equipped with a single missile launcher and rapid fire gun, providing substantially better local area defense. As built, the Perry class's ASW suite is unimpressive; the hullmounted SQS-56 sonar offers only limited range. This capability has been augmented by the planned installation of towed-array passive sonar systems in both active and NRF ships, and the capacity to maintain two SH-60B or SH-2F ASW torpedo-bearing helicopters aboard.<sup>151</sup>

Integral to the design of this ship class was the significant reduction in personnel required to serve

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<sup>150</sup>Polmar, Ships and Aircraft of the U. S. Fleet, pp. 170-172.

<sup>151</sup>Polmar, pp. 160, 162-165.

onboard; this can be seen clearly in comparing the manning levels of the FFG-7 class with previous classes, in Table XXV. The substantial difference in manning levels between the FF-1052 and FFG-7 classes weighs heavily in many of the costing categories evaluated by the body of this text.

TABLE XXV  
NRF UNIT MANNING LEVELS

| Ship Class | Peacetime Manning <sup>152</sup> |          |
|------------|----------------------------------|----------|
|            | Officers                         | Enlisted |
| Gearing    | 17                               | 288      |
| Edson      | 17                               | 275      |
| Knox       | 17                               | 287      |
| Perry      | 13                               | 180      |

<sup>152</sup>Moore, John, ed., Jane's Fighting Ships, 1980-1981, (New York: Jane's Publishing, Inc., 1980), pp. 654, 655, 658; and Polmar, Ships and Aircraft of the U. S. Fleet, pp. 163, 170.

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